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CONTENTS

"Designing for Production — Production of Consumer Goods" *by* B. H. Dyson, M.I.Prod.E., F.I.I.A. 775

"Productivity in the Manufacture of Worm Gear Units" by F. J. Everest, M.Sc., A.C.G.I., D.I.C., M.I.Mech.E., A.M.I.E.E., M.I.Prod.E., A.I.Mech.E. 778

"Gear Measurement and Allied Subjects" by C. Timms, M.Eng., M.I.Mech.E., M.I.Prod.E. 792

"Materials Handling" — A Series of Case Studies 805

The Annual Dinner, 1955 808

Report of the Meeting of Council, October, 1955 812

"Automation — The Institution's Policy" 815

Elections and Transfers 820

Extracts from Local Section Reports 821

Institution Notes 828

The Hazleton Memorial Library 829

News of Members 830

Journal Contents, Vol. 34, 1955 832

Subject Index to Papers published January/December, 1955 . . . 834

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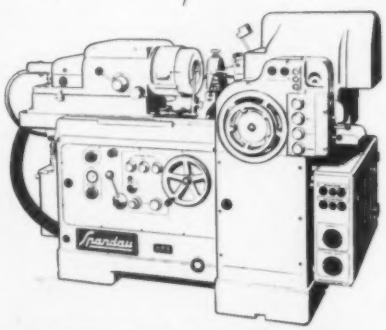

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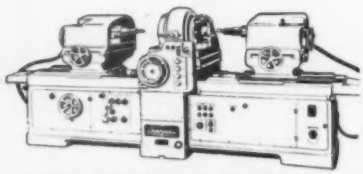

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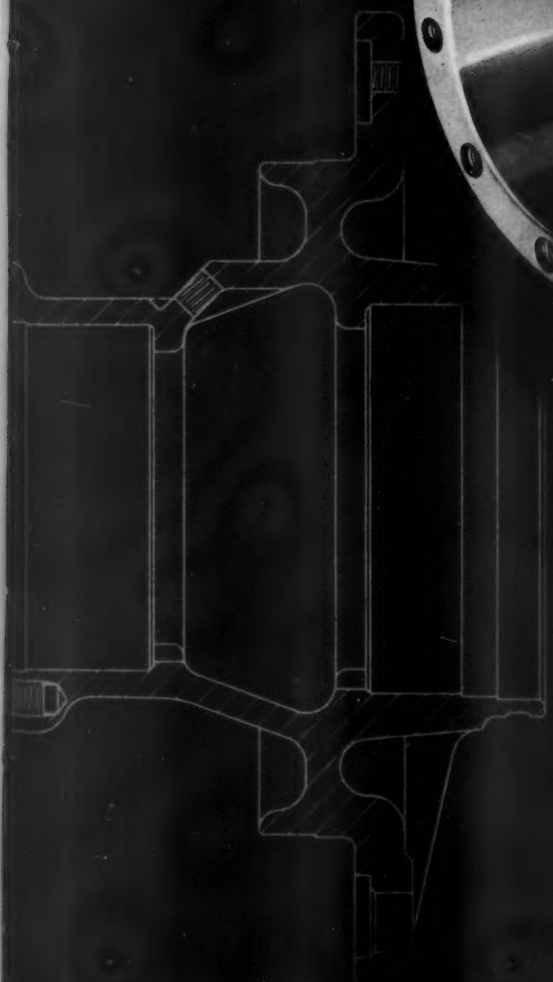

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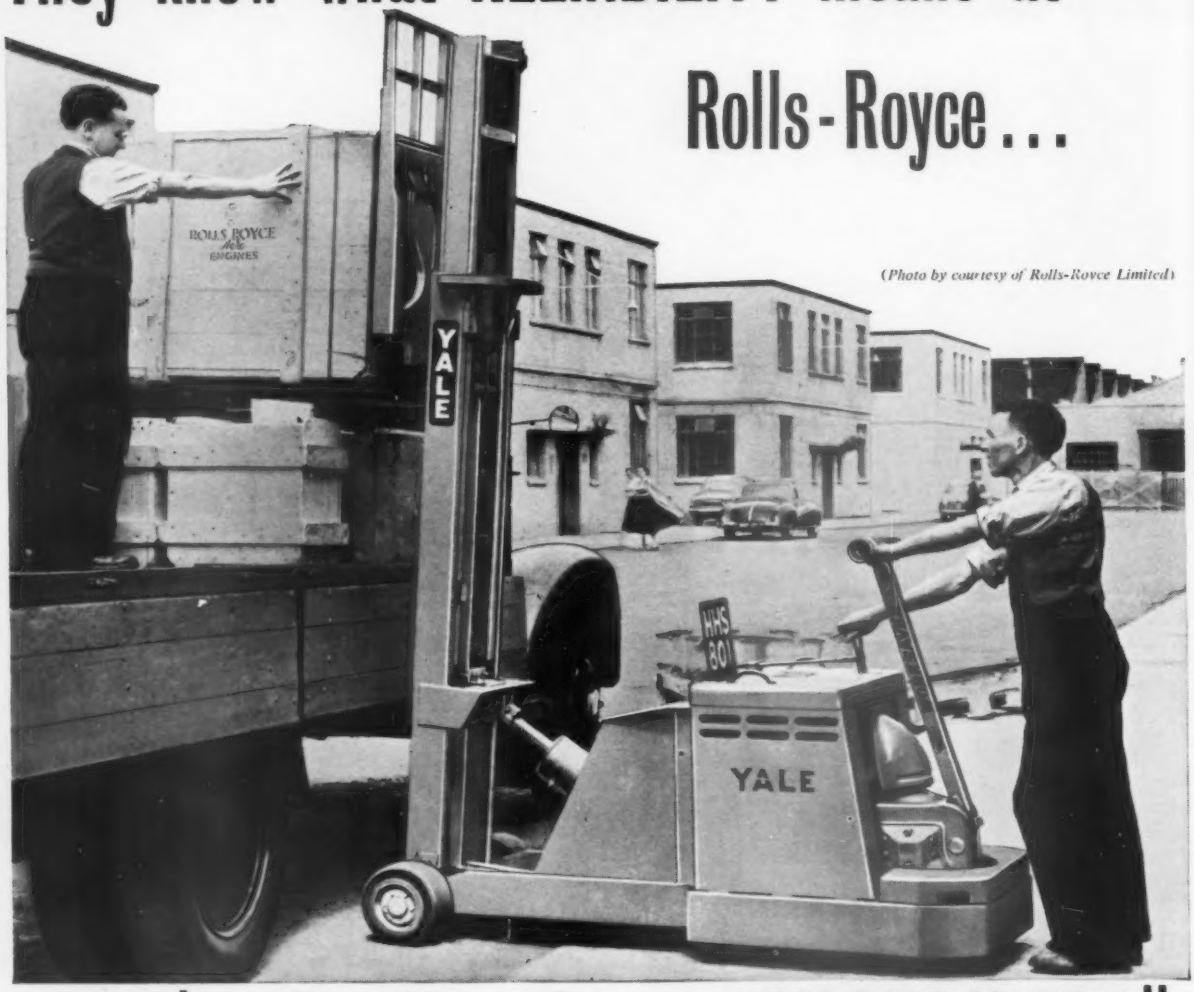

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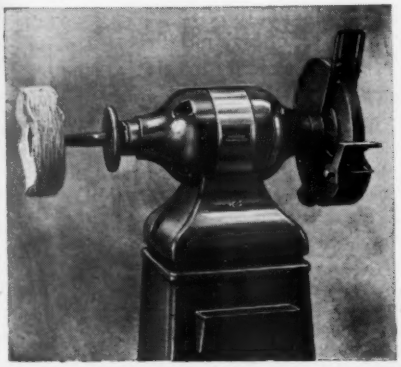

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The Institution of Production Engineers Journal
VOL. 34 NO. 12 DECEMBER, 1955

Designing for Production—Production of Consumer Goods

by B. H. DYSON, M.I.Prod.E., F.I.I.A.,
General Works Manager, Hoover Ltd.;
Chairman, Institution's Research Committee.

DESIGN is the visible and tangible expression of an idea. The idea may be to cover an invention, a potential market, or to increase sales appeal. The expression "DESIGN" is a definition of proportion, composition, structure, appearance, specification, and mechanical and electrical functions.

The Consumer Goods Market

When the term "Design" is applied to consumer goods varying from toasters to television, razors to refrigerators, it must embrace many other facets, e.g., consistent quality, controlled manufacturing costs, and flow production.

Consumer goods invariably enter a large but highly competitive market—from areas opened up by rural electrification to the vast number of city apartment dwellers; from England, the most carpeted country in the world, to the rush mat huts of Brazil. This widespread market, so extensive and diverse in its many needs, demands first and foremost that the design should meet all specific local requirements and measure up to foreign competition in functional efficiency, eye appeal, and cost. Often in overseas markets a typical British design is not acceptable and the overseas customer cannot always be sold the idea that the British home market is the acme of good design. This presents both a design and a production problem.

In this highly competitive market not only must a product be right mechanically and electrically, but it must also *look* right, and of course this latter concept may be variable from year to year. In designing consumer goods one of the primary aims is to achieve an attractive and 'cleanline' appearance which will appeal to potential customers. The designer's responsibility does not, however, end here, for of even more importance than the 'cleanline' appearance is the attention to detail to ensure easy operation and control, safety and resistance to damage, and easy and cheap maintenance. Style and colour as well as speciality selling features must strive to be at least abreast of competition and, if possible, in advance. In other words, the product must be a fashion leader and not a fashion follower.

The design of consumer goods needs to be well reasoned and not too far in advance of the buying public's tastes. A world-renowned consumer goods designer once explained that he had to make frequent world tours of observation in order to be able to assess the right level. There is the case of a domestic product where an advanced design was so far ahead of the market that although it was tooled for a production of 250,000 per year, sales never reached 1,000 per week. On the other hand, there are many examples of a product being so well in the forefront of accepted design that it has a production life of several years.

Competition demands high value for money, immediate delivery and consistent quality, and this combination calls for design and production co-ordination. There can be no weekly or monthly design modifications; Mrs. Smith pays the same price and therefore expects the same product of a given consumer goods model as that purchased by Mrs. Jones.

If the design of the product or even each individual component is not efficient from a functional or accepted standard point of view, no matter how perfect the manufacturing may be, the desired results will not be achieved. The design office and the drawing board are the cradle and kindergarten of production costs. Research into the question of designing for flow line low cost production is an important step toward increasing productivity and enhancing sales.

Service after Sales

Servicing the consumer product is a combined sales and production problem very closely allied to design. The design must be such that unit construction will allow for easy replacement wherever possible on site.

The first questions the customer asks when the product fails are; "How long shall I be without it?", and: "How much will the repair cost?". In the consumer goods market, a period of guarantee including free replacement of defective parts is almost accepted practice, and this is an expense largely controlled by design and production standards. It is often the case that greater operating efficiency, in parallel with lower maintenance costs, are the governing requirements before a large potential market can actually be captured. This was very true in the case of the television industry.

Reliable and consistent functioning of a product will build customer confidence. Widespread competitive markets make it essential not only for the product to function equally well under Antarctic or Equatorial conditions, but also for the ready replacement of wearing parts and immediate delivery of service spares. Parts must be of guaranteed interchangeability, sometimes even to accommodate the wear in existing mating parts. The design should ensure that the fitting of the replacement parts can be done with the simplest of domestic tools. Both quality and interchangeability are often as dependent on design as they are on good workmanship.

The Design Function

Sometimes the design function is considered fulfilled once the styling, mechanical and electrical requirements are complete and acceptable, but with large-scale flow production it is necessary for design to provide a specification for appearance standards, noise and vibration tolerances, because if these are controversial, production costs may fluctuate with the Junior Inspector's whims and fancies.

Present-day costs will demonstrate that packing, cartoning, and safe transport to the ultimate customer are problems in themselves and also prove to be a very expensive job. The design, not only of the product, but also of the container, must be resistent to transit damage with due regard to economic manufacture and transit costs. Here again, this is a combined design and production problem.

While the real scope of design can cover a wide field, the specification, shape and dimensions of the detailed component parts also need experienced attention and must not be left to the inexperienced junior detail draughtsman. If component drawings are not considered from a production point of view, expensive tooling and processes can often needlessly be installed. Often production is retarded because dimensional standards are not defined or are not consistent with actual requirements, and surface finish (which is always an expensive production operation) is undefined and left to personal opinion. There is also the problem of the tolerances on the component parts not being consistent with the tolerances that could be allowable in the specification of the assembly.

Gone are the days when the consumer goods catalogues and advertisements used the phrases; "massive construction", "solid steel covers", "iron of heavy section", "robust heavy design", all of which glorified sheer weight as representing quality. Invariably it will be found that it is lack of good detail design that results in clumsy heavy products. Where compactness is required in order to conserve space (as, for instance, in the case of washing machines and refrigerators) bulky and heavy designs restrict the market. This aspect is particularly important where a product has to be lifted and carried—a typical example is the modern camera; not until the clumsy plate camera with tripod was replaced by the light folding film type design did the camera industry really require any real production.

An analysis of present-day production costs of consumer goods invariably indicates that material costs can represent 30%-40% of the factory cost. More important is the fact that the percentage of material purchased which is converted into saleable goods is seldom greater than 70% and frequently less than 30% (as has been illustrated in the recent Institution of Production Engineers Report on " Material Utilisation "). Co-ordination of design and production activities must aim at the highest possible material utilisation. In component design lack of foresight can result in ill-considered shapes and dimensions with a consequent high percentage " blanking " scrap, or in material removal operations producing " swarf " scrap. If design is not carefully considered in relation to existing stock sizes then higher costs, long delivery, excessive raw material stocks and unnecessary machining will result.

Design and Production Co-ordination

To achieve the best results, it is essential that from the earliest stages designers and production engineers work together in close co-operation to evolve a design best suited for efficient production without sacrificing appearance or performance. This close co-ordination must exist right through the drawing board stage to the production of the prototype models and to the trial production batch. It is also important during these stages that the Buyer and the appropriate outside suppliers are brought in for consultation.

The main objectives should be to direct research into :-

1. reduction of the number of component parts;
2. reduction in the number of production operations;
3. minimum metal removal operations; and
4. standardisation of detail.

There is an example of a domestic product where, by a combination of design and production research, the total number of component parts in one particular product was reduced from 764 to 508 and the number of sub-assemblies from 59 to 45. At the same time a considerable improvement was made to the appearance and performance of the product.

Very often a newly-developed material or process needs to be introduced, and it is under such circumstances that difficulties and mistakes are encountered owing to lack of close co-operation between the designer draughtsman and the production engineer in the early stages of the product development. For example, it may be that a moulding process is required to be introduced and the designer or draughtsman does not appreciate the moulding technique with regard to mould cavity design and powder flow, flash line location in relation to rib design, flanges or undercuts in relation to side cores, loose cores, or the ejection of the moulding. To take another example, die castings may be introduced in which the process is not fully appreciated by the designer with regard to metal flow, draft on the die, distortion and contraction problems relative to variations in section thicknesses, or die design problems relative to the location of bosses, fillets, radii, and cored holes. Very often the production time and costs of a component are relative to the " down time " of moulds and dies, due to heavy maintenance. With the advance of mechanical handling and machining, automatic machine operation and transfer machine lines, the majority of metal forming and machining operations can be controlled and operated with a minimum of direct operators. However, the maintenance of the cutting tools and the removal of the machining scrap and swarf may need an army of people. The reduction of material removal operations should therefore be one of the ultimate objectives.

Obvious alternatives are the use of extruded sections, impact extrusions, investment castings, cold heading and upsetting, powder metallurgy, etc. Possibly one of the most expensive production operations is metal finishing both as regards the preparation work and the very low utilisation of material. The design specification can assist production by :-

1. reducing to a minimum the variety of finishes;
2. standardising chemical or plated finishes that assist the economics of mechanising the finishing processes;
3. commoning-up and standardising on the undercoats for enamel finishes;

(*concluded on page* 827)

PRODUCTIVITY IN THE MANUFACTURE OF WORM GEAR UNITS

by F. J. EVEREST,

M.Sc., A.C.G.I., D.I.C., M.I.Mech.E., A.M.I.E.E., M.I.Prod.E., A.I.Mar.E.

Presented to the Halifax Section of the Institution, 1st February, 1955.

Mr. Everest was educated at Rugby School, Rugby College of Technology, and City & Guilds (Engineering) College. He served his apprenticeship with the British Thomson-Houston Company, Rugby, and in 1931 gained a B.T.H. Fellowship, which covered 12 months' experience with the General Electric Company in America.

In 1932 he became Design Engineer with the British Thomson-Houston Company, responsible for the design of a wide range of mechanical and electrical industrial equipment, and the study of associated technical problems. He was subsequently appointed Chief Engineer with David Brown & Sons (Huddersfield) Ltd., and, in 1944, Chief Engineer of the David Brown Group of Companies, involving executive responsibility for designs, development, technical data and standards, inspection, and quality control. In 1951 he took up his present appointment, as Manager of the Park Gear Works, David Brown & Sons (Huddersfield) Ltd.

Mr. Everest is Chairman of the Halifax Section of the Institution.

Mr. Everest

IN opening a lecture on this subject, it is desirable to start by defining what is meant by " productivity ", and to differentiate between that and the outmoded conception of " production at any cost ".

To attain high productivity is to achieve the maximum output per man hour, at the minimum cost, and to the requisite degree of accuracy and quality in the product being manufactured. In short, high productivity will achieve for the customer the best degree of satisfaction in terms of delivery, price, and quality, and should also yield to the manufacturer, and to the employee alike, an adequate and a generous reward for their efforts.

There are several reasons for the choice of worm gear units as the subject of this lecture on " Productivity ". In the first place, this is a typical British engineering product, manufactured in relatively small batches, and to a very large degree tailor-made to suit a wide range of applications, and in this limited batch, specially-tailored type of production, I believe this country still leads the world.

There is a further reason for lecturing on worm gear units in Huddersfield, since this is an engineering product which has been pioneered and developed very largely here in this town.

The worm gear unit is a means of power trans-

mission between a high speed prime mover and a low speed shaft, suitable for driving a wide range of industrial equipment.

In Fig. 1 is shown a demonstration model, having a plastic case so as to reveal the internal construction. Basically, the unit is composed of three major parts. The case, which is shown here in plastic and would normally be in cast iron, the wormshaft in case-hardened steel, and the wheel assembly on its own shaft.

Present Manufacturing Methods

I will deal first of all with the methods of manufacture current today. The two halves of the case arrive into the factory as rough iron castings. Formerly, these were stored in an open yard and, by the time they were required for issue to the machine shop, they were often badly corroded, requiring a tremendous amount of fettling, and hundreds of man-hours were consumed in restoring them to a satisfactory condition.

Under the present system, immediately on arrival into the works, all iron castings are shot-blasted to prepare them for spray painting. A quick-drying, weather-resisting paint is used, and the cases immediately pass along the roller conveyor and out into a stockyard, where they are stored until called upon for machining.

When the half cases are issued into the factory, the first operations are machining the base and the joint flanges. These are carried out by planing, plano-milling, or surface grinding, dependent on the size and quantity involved.

When the two halves of the case have had their joint faces machined, they are drilled and bolted up, and the complete case then goes forward to the

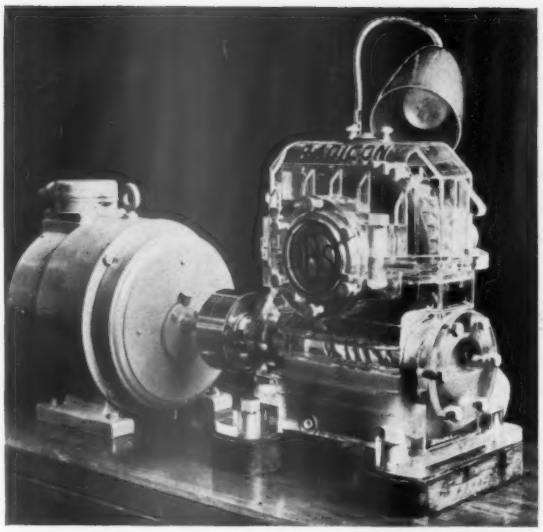

Fig. 1. Worm reduction gear unit fitted with plastic case showing internal construction.

boring operation. A special-purpose machine for this work, having four boring heads, is illustrated in Fig. 2, and this method has considerable advantages. It is vital in the operation of worm gears that the two gear shafts are mounted accurately at right angles, and to achieve this reliably and economically is very easy with a machine of this kind.

Although the setting-up time for each new batch is quite appreciable, the boring and facing operations are carried out quickly and accurately.

Fig. 2. Special purpose 4-spindle borer for boring and facing four boring housings simultaneously.

Fig. 3. Copy lathe turning of wormshafts using plate template.

The bolted-up case now goes forward for the drilling and tapping of the holes in the end facings, multi-spindle drills being used where applicable, and the fully-machined case then proceeds to a finished-parts stores.

The second major component in this type of unit is the wormshaft. These are received into the works in the form of either stampings or forgings. There is considerable advantage in the use of stampings, where quantities are sufficient, in the reduced machining time.

A forging is usually too rough to be put straight on to a copy lathe, and has to undergo a rough turning operation first, so there is a saving in machining time by the use of stampings. In Fig. 3 a wormshaft blank is shown being turned on a copy lathe, using a plate template. This template, which takes the place of the usual cylindrical master blank, is divided into two halves. The part which corresponds with the central worm portion of the wormshaft has to be varied, of course, with the diameter of the worm, depending on the ratio of the gears, while the other, corresponding with the shaft ends, is common for all ratios.

Fig. 4. Form milling worm threads in worm milling machine.

After the wormshaft has been turned on the copy lathe, it is ready for the cutting of the worm threads. There are various methods of carrying out this operation; the most commonly used is by rotary form milling, and this operation is seen being carried out in Fig. 4. In the case of a multi-start worm, of course, the blank is indexed after the milling of each spiral gash, so as to form the multi-start thread.

Other Methods

Other methods employed include hobbing and shaping using a pinion-type cutter. There are other methods, such as rolling, but these all have serious limitations. Hobbing, for example, is only applicable to worms of long lead angle, *i.e.* 45° and upwards, which means it is limited to multi-start worms of long lead. The shaping method only covers worms at the other extreme end of the range, *i.e.* short lead, single-start worms. The formed rotary milling process covers the whole range, but there is an even more important advantage with this type of cutter. With the hob, and with the shaping cutter, the tool is geared into the worm, and the cutter speed of rotation is therefore linked with the speed of rotation of the blank itself. This imposes a severe limitation on the cutting speed. With a formed rotary milling cutter there is no such limitation, and the rotary milling cutter may be revolved at the optimum speed to give the best cutting conditions.

The thread rolling process is only applicable to relatively small worms required in large quantities, and primarily to those which are to be left in the soft condition. Quite a high degree of accuracy and surface finish is attainable at high rates of production.

In the worm reduction units such as we are now discussing, the worms are invariably casehardened and ground, which is necessary in order to achieve the high load rating which is required.

When the thread has been formed, the worm then passes into the Hardening Shop, for casehardening. This was carried out for many years by pack carburising, but lately gas carburising has proved to be more economical and a better method, yielding higher productivity. The gas carburising plant employs batch type furnaces, in which the carriers are loaded with a charge of worms suspended vertically.

It might be thought that a continuous furnace would yield higher productivity in the hardening of worms, but, in this class of manufacture, that is not necessarily true. It has to be borne in mind that a large range of sizes is involved and, for each size of unit, there is a wide range of ratios and pitch. Hence this work is better dealt with on a batch basis, so that the heat-treatment conditions can be selected as the ideal for each batch.

The suspension in the vertical position is desirable, so as to achieve minimum deflection both in the hardening and the quenching.

The gas carburising process is very much cleaner than pack carburising, and it is cheaper to an extent varying from about 10 to 30%. With suitable steel,

it should be possible to quench direct from the hardening operation, while with pack carburising, the charge must be allowed to cool, followed by reheat and quenching. Gas carburising can, under ideal conditions, permit the omission of this reheat, and allow a quench direct from the hardening.

Surface Hardening

There is an alternative method of hardening worms by some form of surface hardening, the two main processes being flame-hardening and electric, high-frequency induction. In either of these methods, the results are not too satisfactory. In the first place, one is limited metallurgically to a restricted range of steels which are not ideal in other respects. Secondly, it is necessary, by trial and error, to arrive at the correct shape of gas jet, or electric inductors, and the shape of these is very critical indeed. Their positioning in relation to the flanks of the worm thread has also to be maintained extremely accurately, otherwise faulty hardening will result.

It would be a very difficult problem to develop and have available inductors for a wide range of work, and impracticable to apply this technique to jobbing work.

With surface hardening, of course, a relatively high carbon steel is necessary, and there is a considerable risk of cracking in the quenching, in the subsequent grinding, or in service.

One of the advantages of gas carburising lies in the ability to control the carbon content in the case of the gear. This percentage can be controlled down to about 1% carbon, which is much easier to handle without risk of cracking in the subsequent operations of grinding, and is much more reliable in service under heavily loaded conditions.

Sections through two worm threads are shown in Fig. 5, indicating the different form of case obtained with carburising; it will be noted that there is uniformity of depth of case right round the tooth profile. With an induction- or flame-hardened gear, the depth of case varies from a maximum at the mid-depth of the tooth and runs out almost to nothing at the point of maximum stress, at the root of the tooth, which is of course undesirable.

After hardening, the worm comes back into the Machine Shop, and resulting distortions are removed by a subsequent grinding operation. Also, the surface finish required for satisfactory operation is obtained by this grinding.

Methods of Grinding

There is a variety of methods of grinding, the choice depending to some extent on the form of thread required. The British Standard Specification on the subject, B.S.S. 721, recommends the involute helicoid thread form. One of the reasons for that initial recommendation was that this form of thread can be ground by a straight-sided grinding wheel that can be easily trimmed by means of a diamond travelling along a straight line path. Machines which operate on this principle can only grind one

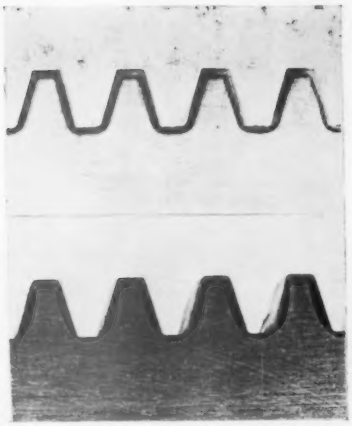

Fig. 5. Sections through worm threads showing hardened case pattern produced by carburising *(above)* and surface hardening *(below)*.

flank at a time, and usually in one direction of travel of the worm carriage.

During the idle return stroke, of course, indexing takes place on a multi-start worm, so that the grinding wheel enters the next tooth space, ready for the next grinding stroke.

A Later Development

A later development is to employ a formed wheel which grinds both flanks at once, rather in the same way that the rotary milling cutter mills both flanks at once. Even with the British Standard tooth form, this method necessitates the use of a grinding wheel which is trimmed with a diamond to a special curved shape. The advantage of the involute helicoid worm is still retained, however, in the ease of inspection. On machines of this type, the diamond trimming is effected hydraulically and the lost time is minimised by a speedier return, while simultaneously the machine automatically indexes round to the next thread.

There are grinding machines available which grind on the return stroke but, in order to do that, two conditions must be satisfied. Provision must be made for run-out of the grinding wheel beyond the ends of the worm, sufficient to give time to index, and that must occur at both ends of the worm.

The second requirement is that the machine must automatically compensate for the backlash in the gear train mechanism between the grinding wheel motion and the worm table motion, otherwise, as soon as the grinding wheel came into the worm to start grinding on the return stroke it would be out of index, and it would foul the wheel.

A large proportion of worms will not permit the grinding wheel to run out clear of the threads, owing to the presence of a collar or shoulder, so that the best general-purpose machine for grinding worms to fit into this type of worm reduction unit is still the double-sided grinding machine, grinding on one stroke and returning on a fast idle stroke, and indexing during this return stroke.

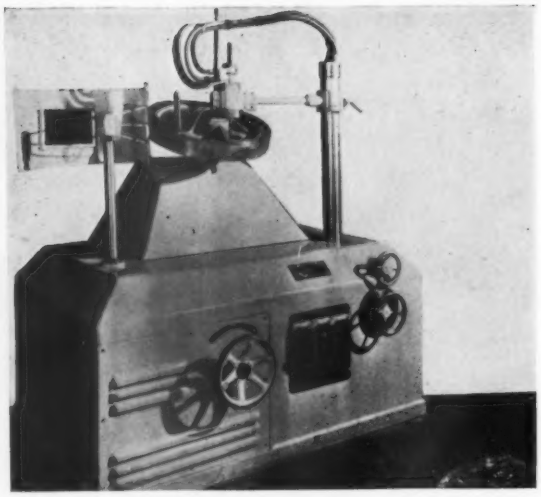

Fig. 6. Welding bronze wormwheel rim to cast iron centre on electric arc welding machine.

Just as case-hardened nickel molybdenum, or nickel chrome case-hardened steel is the ideal for the wormshaft, so experiment and experience have shown that phosphor bronze, of about 12% tin content, gives the optimum conditions for the operation of the wormwheel. This particular type of phosphor bronze is, in fact, generally the best for machinability, which is rather a fortunate coincidence.

There are two methods of casting the phosphor bronze rim blanks. These can either be cast in a static mould, or centrifugally into a spinning mould.

In the case of the static casting, a coarse grain structure is obtained, while in a centrifugal casting a fine homogeneous structure results, and this does show up very markedly in the load carrying capacity of the wormwheel, in service, and also in the machinability of the wormwheel blank.

Phosphor bronze is a relatively expensive material, and, for that reason, in all but the very small sizes of wormwheel, the wormwheel blank is formed from an annular rim or ring of phosphor bronze, in which the teeth are cut, which is mounted on a cast iron centre. This raises the problem of fixing the rim to the centre, and there is a variety of methods employed.

Perhaps the oldest method is to shrink the finished-turned rim on to the centre, and then to insert pegs, half in the rim and half in the centre.

A More Modern Process

A more modern process now employed for fixing the rims to the centres is by electric welding. In Fig. 6 is seen a welding machine developed specially for carrying out this particular operation. The rim is again shrunk on to the centre, but with a smaller shrinkage fit, and the welding takes place automatically as the blank rotates under the arc. This produces a clean and uniform result. This is not a weld in the true sense, so much as a fusing and a mechanical keying and bonding between the two materials.

Tests have shown this particular construction to offer very high resistance to lateral loads tending to push the rim off, as well as to torsional loads.

An interesting method of construction is to cast the phosphor bronze rim direct on to a cast iron centre. There is a fundamental difficulty with this process, however, which arises from the fact that the thermal coefficient of expansion of bronze is very much higher than that of cast iron. No matter whether the centre is preheated or not, when the bronze is poured into the mould and cools with the centre, the rim attempts to contract more than the cast iron centre. The centre will not allow the rim to shrink in its natural way, and it will inevitably remain in a condition of tensile stress. In some instances, the cast iron centre has been known to be crushed and to collapse under the shrinkage stress of the bronze rim.

The wormwheel blank is finish turned, and then goes on for cutting of the teeth. Fig. 7 shows a blank on a wormwheel generator, or a hobbing machine.

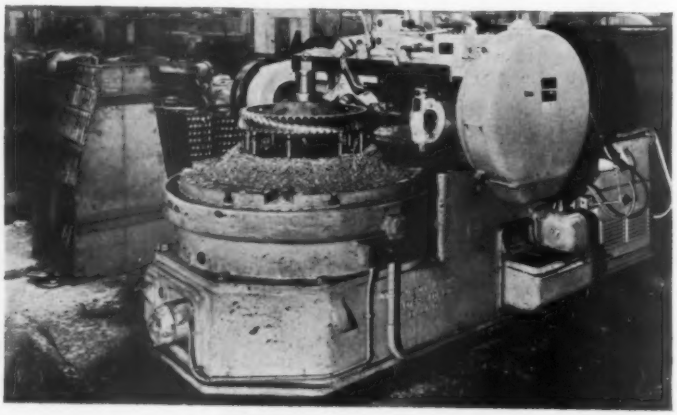

Fig. 7. Wormwheel being hobbed on wormwheel generator.

The process has many variations, but the best practice is to use a parallel roughing hob and follow with a serrated finishing, or reamer, hob. The latter is necessary, since the roughing hob has form-relieved teeth, and, therefore, when the cutting faces are sharpened back, the hob reduces in diameter. It is one of the cardinal principles in worm gearing that the hob must be substantially a replica of the worm which is to mate ultimately with the wheel being cut, and that cannot be if the hob, every time it is sharpened, changes diameter.

That is a difficulty which can be overcome to a certain extent by imparting a slight swing to the axis of the hob in relation to the wheel, but the ideal solution, where one has sufficient quantity batches, is to have a serrated finishing hob which is exactly of the diameter required.

So much for the manufacture of the three major components. These go forward then to a finished-part stores, and, after they have been marshalled together by the storekeeper with the bearings, oil seals, and other fitments, they are then issued into the Assembly Shop at the appropriate time.

Importance of Assembly

All the major parts are manufactured to close drawing tolerances, therefore the building up of these units is essentially an assembly, not a fitting, job. The most critical operation is the adjustment laterally of the wheel in relation to the worm, so as to achieve the correct contact marking, and that is obtained by shimming of the bearing end covers so that location of the wheel is correct in relation to the worm.

The assembled unit is given a light test run and then passes forward, to the paint spray booth, where it is given a final paint spray. A roller conveyor is used for transporting these particular units to the spray booth.

Throughout all this Machine Shop work, use is made of modern mechanical handling processes. For example, in bringing the castings from the Casting Stores down into the Machine Shop, fork lift trucks and the pallet system are employed.

Fig. 8 shows a truck dealing with a load of cases, six being mounted on to each wooden pallet. Within the Shop itself, the heavier worms and wheels are dealt with in stillages, and a run-about truck can be used to move these about. Alternatively, a crane can be used for the movement of stillages.

Rack conveyors are used for small, light items, and these are wheeled from machine to machine, and represent a very convenient way of handling small worms and wheels.

In this manufacturing procedure, inspection has an important part to play and, in order to permit assembly, rather than fitting, it is essential that all parts are passed off to the correct drawing limits. Fig. 9 shows a special worm gear testing machine, for checking the lead angle and the general shape of the worm threads. The two gears, the worm and the wheel, are also meshed together and, by means of blue marking, the contact is observed. In the batch production that we have been considering, it is customary to have master worms available of all standard ratios, for checking wormwheels, and master wormwheels available of all standard ratios, for checking the worms. In that way, complete interchangeability from the point of view of assembly and service is achieved.

Fig. 8. Handling of cast iron cases on wooden pallets by means of fork lift truck.

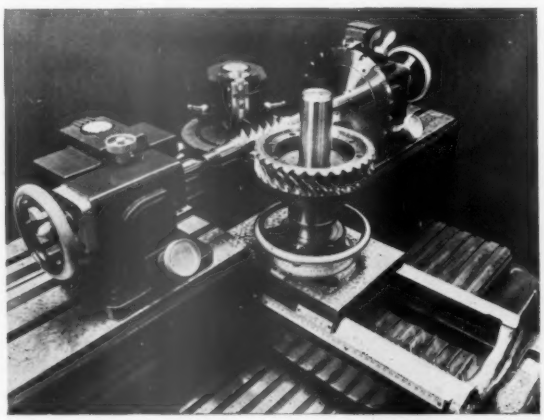

Fig. 9. Worm gears in testing machine.

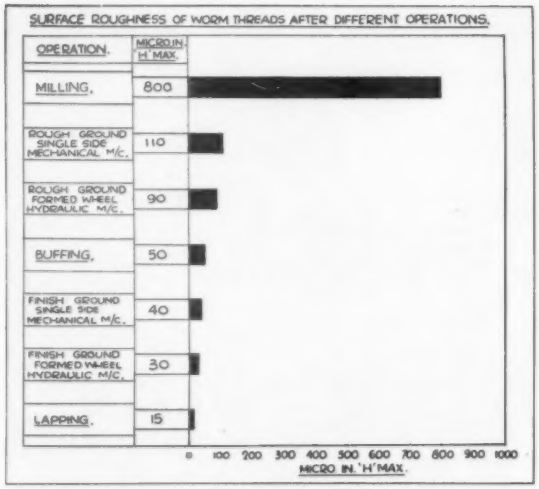

Fig. 10. Surface roughness of worm threads after different operations.

Surface finish on the worm flanks is of vital importance in the satisfactory running of worm gears. Surface finish records show that double-sided grinding gives a rather better finish than single-sided.

Electrolytic polishing can improve the finish on a rough ground worm, but that is of only academic interest. Buffing can produce a good finish but is not a satisfactory shop process. Lapping is sometimes used where the very finest finish is required for precision work, but is not generally applicable. The rough grind coupled with the finish grind is the common production method, the ultimate figure of 30 micro-inches being adequate.

This is shown in a different form in Fig. 10, where finishes may be compared with that which is obtained from the milling operation.

An important factor in obtaining high productivity in engineering manufacture is the vital subject of production control. The first duty of production control involves making the necessary arrangements for the flow of material to the works, *i.e.* the raw materials, such as castings, forgings, etc., at the right rate and at the right time to meet the necessary production programme. Secondly, standard parts, after machining in batches, must be held in stock ready for assembly into units as and when required.

A stock of finished machined cases which have gone forward through all the machining cycles, is held at the finished-part stores, where they are methodically controlled and made available as required.

Similarly a store holds standard wheels, worms, and, in the bins, all the miscellaneous parts—bearings, oil seals, and so on, and it is one of the vital duties of production control to see that all these parts are available at the right time, and in the right quantity.

As already mentioned, however, this particular product is tailor-made to a very large degree and, although standard designs, standard ratios, etc., are available, there are many calls for special features

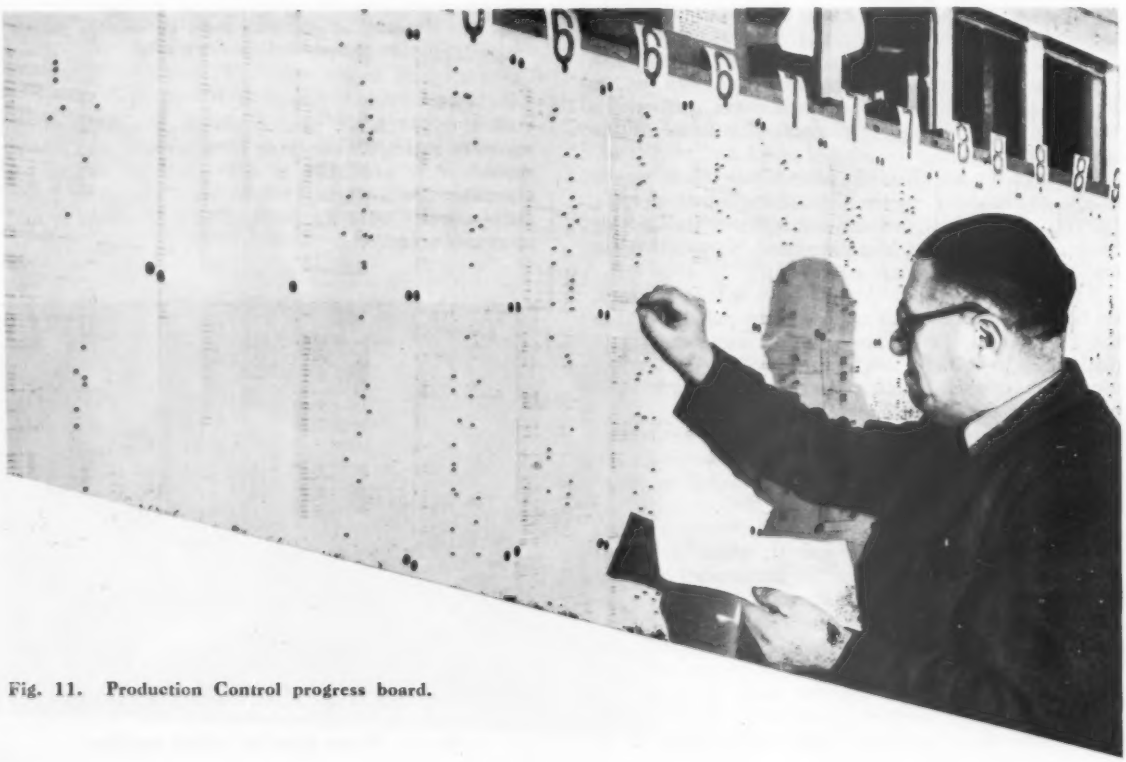

Fig. 11. Production Control progress board.

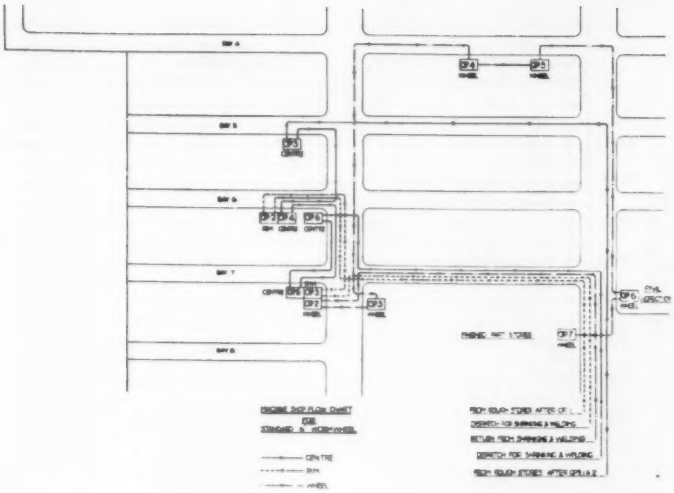

Fig. 12. Machine shop flow chart for standard 6″ wormwheel.

and special parts. This means that, mixed up with the batch production of standard parts, there is a vast complexity of special parts, all proceeding through the Machine Shops simultaneously.

The problem of controlling these special items is very much greater than that of maintaining the supply of raw materials or of standard parts. Unless some system is devised and operated for controlling the manufacture and the flow of the special parts through the Shops, chaos is bound to reign.

In Fig. 11 is illustrated one method of tackling this problem, involving the use of a wall chart which is arranged to show, period by period, details of order numbers, job numbers, customers, and so on, and, by means of coloured pins, it is possible to log and record continuously the progress of all these jobs.

Proof of the value of effective production control is clear from the results achieved in a particular shop manufacturing these products. In 1949, the output and the work in progress figures are given as 100%. Without any basic change in the productive capacity of the shop, the output remained substantially constant until 1951, and then it shot up by 60% in one year. That coincides with the introduction of improved production control. Simultaneously, the work in progress came down to less than half what it was before.

A curve of output rather than productivity is given, since half of the increase in 1951-52 was achieved by the consumption of parts already made but not properly co-ordinated, and it was by improved production control that these were turned into useful output.

Another aspect of production control which is very important is shop layout. Fig. 12 is a diagram illustrating a general machine shop in which these units are manufactured, along with many other products, and the policy then was to group like

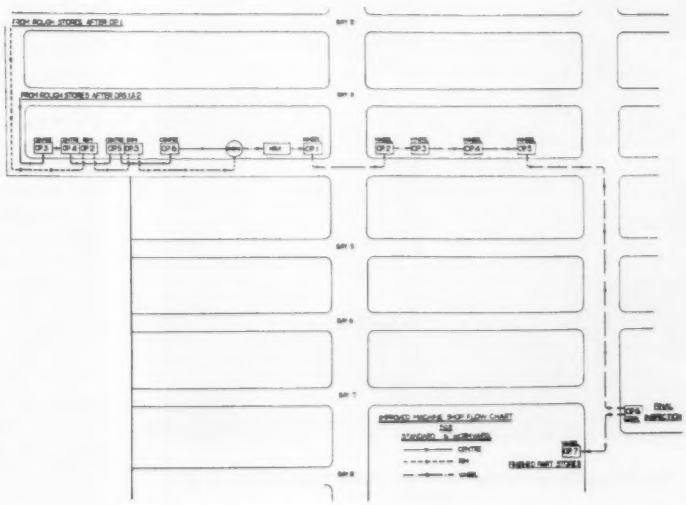

Fig. 13. Improved machine shop flow chart for standard 6″ wormwheel.

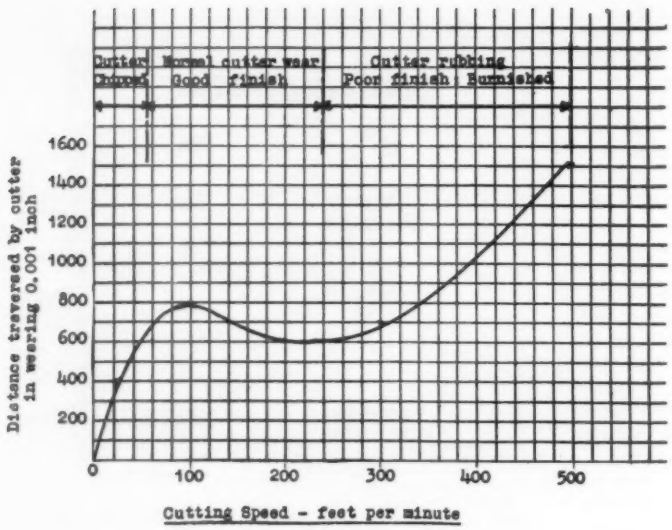

Fig. 14. Curve showing effective cutter speed on machinability of bronze.

machines together, for obvious reasons. The distance travelled by the component parts of a standard 6″ wormwheel during manufacture totalled approximately five miles. Fig. 13 shows that, by bringing all that relevant plant into one production line, in one bay, that five-mile journey can be reduced to 100 yards.

Although there are advantages in the former method of grouping like machines, clearly, if one is concerned solely with the productivity of a particular article, there is no question that line production has tremendous advantages.

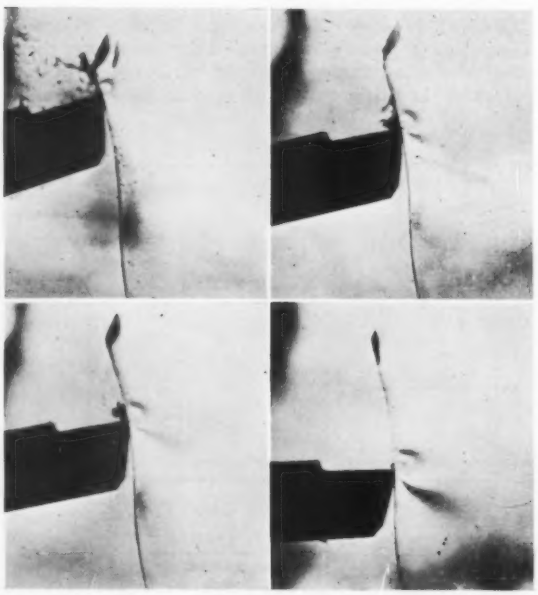

Fig. 15. Photoelastic analysis of cutting action at low speed.

Continuing Research

Technical departments have their part to play in the drive for productivity. Research, for example, is proceeding continuously. Tests were carried out to find the effect of cutter speed on the cutting of various bronzes, and it was found that phosphor bronze centrifugally cast is very much more machineable than phosphor bronze sand cast, and the optimum cutting speed is higher also.

By taking tests at higher cutting speeds, the interesting results shown in Fig. 14 are obtained. Unfortunately, only between the limits indicated is a satisfactory finish obtained.

Advantage cannot be taken of the apparent improvement in cutting performance at the higher speeds because the cutting is not clean and the work becomes burnished. Fig. 15 reproduces actual photographs taken in a Polariscope, showing a single point cutter travelling in an upwards direction, and taking a chip out of a disc blank. It will be seen from the fringes obtained in the photoelastic pictures that a considerable shock blow takes place at the first point of contact. As the cutter travels higher up the blank, this stress pattern gradually reduces, hence it can be concluded that most of the damage to a cutter takes place just as the cutter makes first contact with the blank.

In Fig. 16 is shown a series of photographs taken at a much higher cutting speed. Here the first shock seems to produce an even greater stress pattern. Travelling upwards the chip is seen ahead of the cutter. and near the end of the travel the stress pattern seems to have reduced almost to nil. Hence, as the cutting speed becomes faster, there is bigger variation between

the initial and final stresses in the blank. These photographs were taken by means of electronic flash.

Tests were also made to determine the relative efficacy of a high speed steel cutter and a carbide-tipped cutter in cutting bronze, and these indicated the tremendous potential increase in cutting speed as between a tungsten carbide cutter and a high speed steel cutter.

These results have actually been borne out in the hobbing of wormwheels, and in Fig. 17 will be seen a carbide-tipped roughing hob which was prepared to demonstrate a gain of 15 times in the practicable cutting speed.

The cost of a full hob today is such that it is not an economic proposition in general work, unless the quantities are extremely high, but, nevertheless, results of research show that there are potentialities there.

The Design and Development Departments also have their influence on productivity. Apart from keeping up to date with the requisite programme in the issuing of drawings, the Production Drawing Office has the over-riding responsibility of seeking all the time for improvements, both in materials and designs for productivity.

The results of an investigation into different forms of construction of materials for a standard case are given below:—

COMPARATIVE COSTS ON SMALL WORM GEAR CASE MANUFACTURE

(Mould, die, and pattern costs spread over 5 years.)

	Cost Relative to Cast Iron
Cast Iron	1.00
Plastic	0.79
Die Cast Zinc Alloy	1.23
Die Cast Aluminium	1.05
Steel Pressing	1.51

Cast iron, the present standard material, is taken as unity, and the analysis showed that, when constructed in plastic, the cost, including all machining, would be .79, die cast zinc alloy 1.23, die cast aluminium 1.05, and steel pressing 1.51. From these results one might conclude that the plastic was obviously the cheapest proposition but, unfortunately, the characteristics of plastic materials, from the point of view of thermal conductivity, modulus of elasticity, and tendency to creep, are such that they have to be ruled out on technical grounds.

The multiplicity of types and sizes of unit being manufactured is indicated in Fig. 18. This shows just a collection of units taken at random, ready for despatch.

The following are some of the non-standard features which are commonly specified:—

Cases ... Cast or fabricated steel cases for special applications.

Water cooling coils for high ambient temperatures.

Heaters fitted for low ambient temperatures.

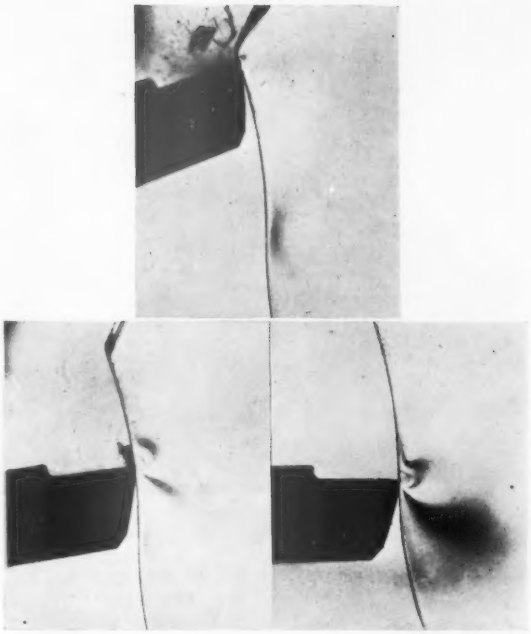

Fig. 16. Photoelastic analysis of cutting action at high speed.

General case modifications to suit special applications.

Special end covers for mounting users' parts.

Holding-down bolt holes for fitted bolts.

Special dipstick arrangements to suit requirements.

Special exterior and interior finishes as requested.

Protection against hosing down.

Arranged to work in unorthodox positions.

Foreign nameplates fitted.

Gears ... 12 standard, and an unlimited number of special ratios.

Fig. 17. Experimental carbide-tipped roughing hob.

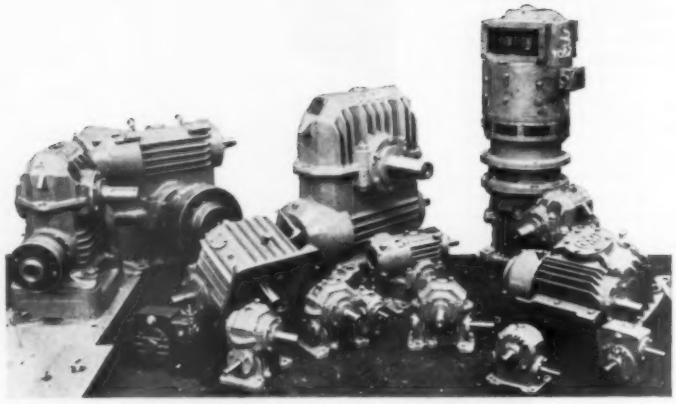

Fig. 18. Worm gear units of various types ready for despatch.

Central contact for lift gears.
Minimum backlash for reversing drives.
Steel wheel centres for shock loading.
Bolted-on wheels (when requested).
Slipping wheel centres for overload protection.

Shafts ... Special extensions (worm and/or wheelshaft).
Special keyways.

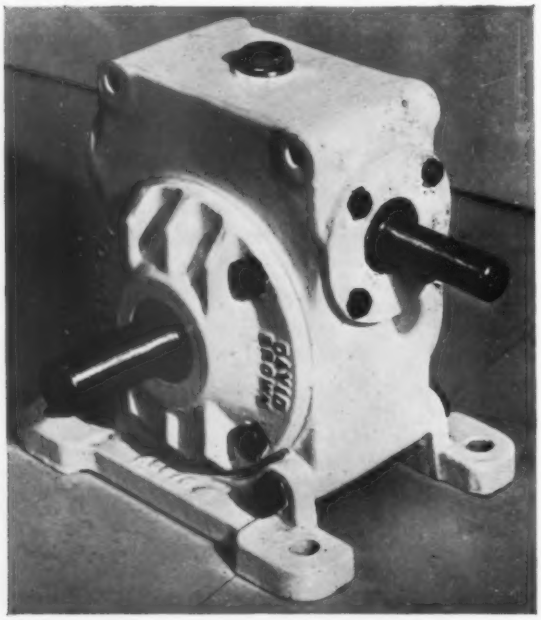

Fig. 19. Universal mounting type small worm gear unit.

Bearings ... Extra roller bearings for overhung loads.
Special bearings for exceptional loading conditions.

Lubrication ... Pressure lubrication for very fast running units.
Stauffer lubrication for very slow running units.

In these circumstances it will be obvious that it is difficult to obtain standardisation to a degree sufficient to facilitate quantity runs in manufacture but, in spite of all these variations in the cases, gears, shafts, bearings, lubrication, and so on, there are certain basic parts which can be standardised to a fair degree.

In Fig. 19 will be seen how, at the smallest end of the range, this problem was tackled some years ago, and a design was evolved where the case is square in form, with four holes in the corners, and the feet are detachable. Fig. 20 illustrates how many different positions can be achieved in the mounting of this particular unit. Hence, by suitable design, a universal-mounting type unit has been evolved, thus permitting much greater use of standard parts. Quantities of these, therefore, become sufficient to facilitate large economical batch production.

Use of Automation

We are now said to be at the start of a second Industrial Revolution, and all round we see increasing use of " automation ". One might be inclined to think that this does not concern engineering works dealing only with relatively small batch work and a multiplicity of special items, but that is not necessarily so; in fact, there is much evidence to indicate that the use of automation and special-purpose transfer machines is becoming increasingly general, even in batch production.

Admittedly, if the principle of line production is established, then it should be relatively simple to go a step further and arrange automatic transference of

material from machine to machine, and automatic loading of these machines. Alternatively, in the class of work we are considering, the transfer machine might have applications, and one of these is in operation on worm reduction unit cases. One operator only is required while bores are machined, housings faced, holes drilled and tapped, as the cases pass from station to station along the machine. The large machine shop with a multiplicity of machines scattered over a wide area is dying, and the advantages to be gained from this new form of manufacture are so tremendous that, in the next few years, there will undoubtedly be very big developments in this direction. It is not wise to assume that these are only for the car manufacturer, the radio manufacturer, and the people who talk in millions. They can, and will, be applied very effectively in batches of 150 and 200.

One can visualise a shop set out to build worm gear units, in which one transfer machine deals with the bottom half cases, another handles the top half cases, the two halves then coming together on roller tracks, and, after bolting up, are fed to a third transfer machine, such as that illustrated, where the complete final machining takes place, and the cases then go forward to the finished-part stores.

Another transfer machine could machine all worm-shaft blanks and turn them up to the gear cutting stage. Similarly, another such machine could take centres and rims and machine them up to the gear cutting stage. Beyond that, the gear cutting shop, I think, will remain much as it is today, for some time.

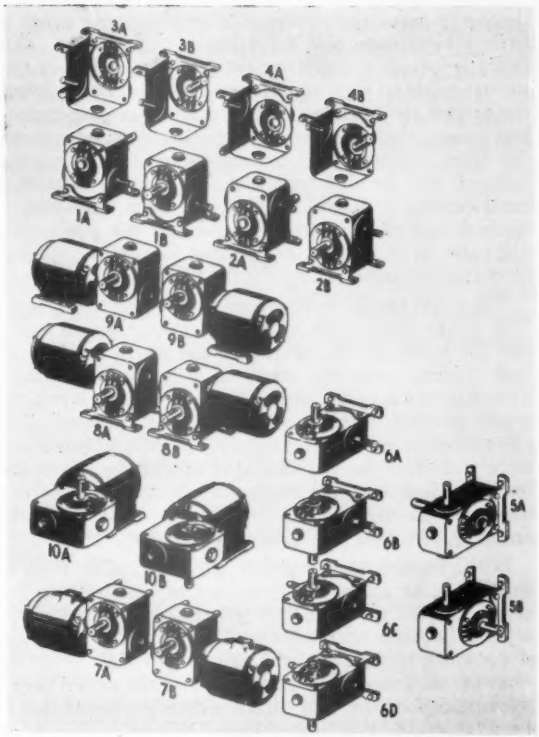

Fig. 20. Alternative mounting positions for Universal type worm gear unit.

The Part of the Production Engineer

To conclude, I would like to stress that high productivity in the future will not be achieved by the old philosophy of incessant appeals to the workpeople to work harder, appeals to them to give up their Sundays, and work seven days a week. It is to the production engineer, and all those concerned with production engineering in any form whatever, that we must look in the full use of their knowledge and experience, their ingenuity and their common sense, and, in short, in the full use of their brains.

DISCUSSION

Chairman: J. E. HILL, M.I.Prod.E., Regional Chairman.

Mr. I. C. Hopkinson: I would like to ask if Mr. Everest has ever experimented with thread whirling for the production of the worm? Does the hob with the carbide teeth at the end come under that heading? Is it applied to a normal, conventional screw thread?

Secondly, on the same subject, has centreless form grinding been applied for your finishing operations?

Mr. Everest elaborated on the care taken in getting down to 30 micro-inches on the worm, but did not make any mention of the finish obtained on the wormwheel from the finish reaming operations. Is it not so important on the wheel as on the worm?

In connection with the mating of the rim on the wormwheel blank, Mr. Everest rather skipped over the welding of the phosphor bronze with the cast iron. We saw a picture of the welding machine with an electrode. Is that a submerged arc form of welding employing either a flux or a gas? There is still the difference of expansion of the two metals to contend with, and I would like to ask how the stresses are got rid of at the point of melting of the two metals?

Mr. Everest: Dealing with the last question first,

there are two basic methods of welding, one using a bronze electrode, and the other a carbon arc. The latter is merely a displacement method, and fuses the bronze without any added material whatever. With the bronze electrode method, which is more expensive, but easier, the slide showed added material to form the fillet. There is no benefit in the use of a submerged arc, as this would tend to cause excessive local heating of the blank, and, provided the welding is done sufficiently quickly, there is no particular difficulty in regard to differential expansion, owing to the initial shrink fit.

The finish on the wormwheel is of course important. The worm is running in mesh with the wormwheel and the worm flanks travel past the wheel flanks at a high sliding velocity, and, if there were surface irregularities, it would act almost as a reamer scraping across the face of the bronze wheel. If, however, the wheel were not of a smooth surface, this would tend to be burnished by the sliding action of the worm, so that the same extreme degree of surface finish is not required on the former. However, the serrated finishing hob does give a very good finish.

With regard to centreless grinding, this is not applicable at all to the grinding of worm threads. Worm thread grinding is a generating process and, as such, involves accurate control between the motion of the work spindle and the grinding wheel.

As far as I know, thread whirling has never been attempted for any but small diameter, short lead screw threads. For longer leads, thread rolling is a more suitable process for small worms which have not to be subsequently hardened.

Mr. J. Blakiston: I think we have had tonight one of the finest lectures which it has been my privilege to listen to in this room, and there are just one or two questions which I would like to ask.

Starting on the foundry side, has Mr. Everest had any experience of the composite centrifugal casting, whereby the bronze rim is spun and, while it is still liquid, the cast iron is poured in to form a composite unit?

Secondly, has he tried the investment process for the casting of the wormwheel teeth? When a solid spun wormwheel is cut into, we all know that the further one digs in, the more open the metal becomes. Very accurate castings can be made by the investment process, and one can also make centrifugal castings with rims formed in this way.

Mr. Everest referred to a forged worm and a drop stamped worm. Modern forgings are made on a forging press, and it is quite simple for the forging press to form the worm contour within reasonable limits.

Is it a good or a bad thing to have such a high finish as 15 micro-inches on the worm? Is it going to preclude the wormwheel from carrying the lubricant? I am wondering are we pursuing the correct path, to finish gears to extremely high finish and then to subject them to some heat treatment operation which results in a very wide distortion arising later in service?

Mr. Everest: Dealing first of all with the question of distortion occurring in gears after they have been in service, I know of no evidence that such things do happen. The worms undergo hardening and quenching, and, in many cases, are stress relieved or annealed afterwards, and the residual stress would be very small indeed. There is certainly no evidence that I know of to indicate that worms have shown any change in their manufactured accuracy after service, arising from the release of stresses set up during the heat treatment process.

Mr. Blakiston suggested that if we have too fine a finish on the gears, the oil might not get a chance to lubricate. The action between the teeth of a worm and wheel is such that they roll into engagement and draw oil in with them, and, in fact, almost ideal conditions of lubrication obtain where you get an oil film wedge, such as you get in a Michell bearing. Regardless of the surface finish, these conditions of lubrication obtain.

The forgings which we have obtained have definitely been much rougher than stampings, and required rough turning in a centre lathe before attempting to finish turn on a copying lathe. Owing to the necessity for expensive dies, the idea of forming the threads by forging or stamping would not be applicable to batch work.

With regard to the question of the composite casting, some work has been done on several versions of this process, but, technically, it would seem to suffer from the same objection as all the other processes for casting rims on centres, namely, that the bronze is left in a state of severe tensile stress, owing to the differential thermal expansion of the two metals.

The investment process does not seem to me to be applicable to industrial wormwheels. It is used extensively, of course, in the casting of small component parts, but is very expensive, and I think the cost would be prohibitive for gears manufactured in that way in relatively small quantities.

A Visitor: I would like to ask the lecturer whether anything has been done with the spraying of duralumin on worm gears? This method has been used for the building up of surfaces of work which has been scrapped, and is excellent in forming a hard surface.

Mr. Everest: I take it that the questioner means spraying of the wormwheel teeth? We don't want a hard surface, but a reasonably soft one, otherwise the wheel would not bed in with the hard and polished worm. Regarding the worm itself, a duralumin surface would be less hard than case-hardened steel. Various treatments have been tried on worms to help them over the initial bedding-in process, such as Parco-lubrising and copper plating. Generally speaking, however, the advantages are not sufficient to justify them as production methods, and there is nothing to beat a well-finished, case-hardened and ground worm.

Dr. Ward: I would have liked to see a slide showing a section through the worm gears, because I am interested in the location of the wormshaft. How is the thrust taken up, and at which end?

Regarding the choice of phosphor bronze for the wormwheel, is that because the metals are dissimilar? We must get away from the idea that it is necessary to have dissimilar materials. With straight spurs, we use steel in both cases.

After the wormshafts have been hardened, do they go to a stretching machine?

In the slide showing the assembly shop there were no visible means of lifting from the stack of cases to the bench. How is this done?

Mr. Everest: The wormshaft has to have the thrust taken on both ends, because it must be capable of operating in both directions, and that is usually achieved by fitting an angular contact bearing at each end.

As regards the use of phosphor bronze for the wormwheel, continuous research is going on all the time into all available materials, and there is none yet which gives, when run with a case-hardened steel worm, as low a coefficient of friction, and as high a life from the point of view of wear, as a 12% tin bronze.

In the days of pack carburising, the amount of distortion was quite considerable, and a shaft which was turned and cut quite true, after it had gone through the heat treatment, would run out of truth, and it was adjusted in a straightening press until it ran true. Although distortions today are considerably less, this is still a standard process—simple, quick, and thoroughly reliable.

Jib cranes are employed in the Assembly Shop for lifting cases and heavy parts on to the assembly benches.

Mr. Macdonald: I would like to ask whether, in regard to hardening, the cyanide, or nitriding, process has been investigated from the point of view of cheapness and wear resistance? Also, has the new I.C.I. process—Sulfinuz—been experimented with, using a cast iron wormwheel and subjecting it to this process, and thereby gaining in improved machining time. With a cast iron wheel, can the worm and wheel be treated in this manner to provide a basic film of lubricant, separating the metal-to-metal surface?

Mr. Everest: One major objection to nitriding is that it takes too long, and in any case is only applicable to certain steels, and the case tends to be shallow and rather brittle. The cost is also considerable, and I doubt whether one could in fact, with a worm of relatively large pitch, get sufficient depth of case. Cyanide hardening is virtually the same—more applicable to shallow case depth work.

The Sulfinuz process is being experimented with, and has shown considerable promise, but more in connection with spur and helical gears rather than worm gears. Again, it is only used to assist in the running-in, and has no ultimate effect on the ability of the gears to carry any particular load, which depends on the choice of materials for worm and wheel.

A Visitor: Has S.G. iron been experimented with, and would it eliminate the composite construction of the wormwheel? Also, could we have a little more explanation of the transfer machine shown in the last slide.

Mr. Everest: S.G. iron has been experimented with very considerably but, from the point of view of coefficient of friction, load carrying capacity, and wear resistance, it has not been found suitable for worm gears, and cannot be compared with phosphor bronze.

Any conventional form of transfer machine can obviously be employed for the machining of gearcases. Boring, facing, drilling, tapping, spot facing, and inspection can be carried out using standard heads. Owing to the right angle bores, either a square form or rotary arrangement can be employed or, with an in-line machine, indexing carried out between operations. Such a machine would need only one operator, but the heads have to be reset between batches. Probably, later on, this resetting will be done automatically, using a punched card system or magnetic tape control.

Mr. Cryer: On the matter of surface finish, the numerical values quoted by Mr. Everest were H max. With the Talysurf of Taylor, Taylor & Hobson, their figures are based on an average reading. If the Institution of Production Engineers could do something about getting a standard for these, it would help considerably.

Mr. Everest: Unfortunately, the H mean figure, is very deceptive. You can get two entirely different characteristics of surface finish with the same H mean figure, and yet one could be absolutely appalling from the point of view of worm finish, and the other satisfactory. H max. does tell you what the deviation is from the crest to the hollows, and that really is very important.

I would not like to suggest to the Council of the Institution of Production Engineers that they usurp the function of the B.S.I. The latter body has already published a standard on this subject, B.S.S. 1134: 1950, and in this the H max or "peak-to-valley average heights" is given as an alternative to the "centre line average heights" method.

GEAR MEASUREMENT AND ALLIED SUBJECTS

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GEAR metrology is not confined to the measurement of gears, but embraces the machines and tools required to produce them. It is closely linked with the study of the machine kinematics, as periodic errors in the main driving shafts of the machine give rise to undulations along the tooth surfaces. It also covers instrument design, and the preparation of national standards of accuracy is a natural development of work in this field.

Improvements in production accuracy depend to a large extent on the provision of methods of measurement which can be readily and quickly applied in engineering workshops and inspection departments. To meet this need various types of universal and single purpose instruments have been developed, each designed for a specific range of gear sizes. For intermediate sizes of gear, covering aero-engine supercharger drives, automobile rear axle drives, etc., the gear component can be readily mounted between the centres of the measuring machine and little difficulty is experienced on account of size and weight. On the other hand, measuring equipment for gears used in marine turbine reduction drives has to be designed for sizes of gear unit ranging from about six inches for helical pinions, to 15 feet diameter for the main reduction gear wheel. The solution to this particular problem has been the development of a range of portable measuring tools which measure individually the errors in each tooth element. By virtue of their portability they can be readily applied to the gear on site. At the other end of the scale the very small sizes of gear (40 D.P. to 200 D.P.) such as are used in clockwork and precision mechanisms, present a major difficulty and a satisfactory system of measurement has yet to be established. For each size of gear, however, the tooth elements requiring examination are essentially the same and the respective instruments used differ only in details of construction and mode of operation.

Limitations of space prevent a detailed study of the subject as a whole and the present paper is a review of existing methods of measurement which, from the Writer's experience, have been found to be satisfactory. Reference is made to some recent developments and the possible trend of future developments in this country is discussed. Suggestions are given for establishing a unified system of pitch tolerances based on the results obtained from a comprehensive series of pitch measurements.

Gear Elements

The complete examination of any gear can be divided into the following sections; although these sections relate specifically to the examination of a spur gear, the general principles involved apply equally well to other types of gear.

Gear Blank

(i) Bore diameter.
(ii) Outside diameter.
(iii) Face Width.

(iv) Concentricity of outside diameter relative to bore.
(v) Axial float of each end face.

Position Measurements

(i) Flank to flank pitch (adjacent).
(ii) Spacing of each set of tooth flanks around a circle concentric with the axis of rotation (cumulative).
(iii) Variations in tooth thickness.
(iv) Eccentricity of the teeth relative to the axis of rotation.

Tooth Profile

(i) Tooth form errors.
(ii) Symmetry of form of the two flanks.
(iii) Tooth thickness.
(iv) Tooth depth.

Tooth Alignment

(i) Alignment of each tooth flank parallel to the axis.

Meshing of Gears

(i) Centre distance
(ii) Backlash at nominal centre distance.
(iii) Uniformity of motion measured relative to a mating gear or an appropriate master gear.

Accuracy of Gear Blank

The production of precision-cut gears necessitates the manufacture of accurate gear blanks[1]. Insufficient care during the preparation of the blank may completely nullify the accuracy of gear cutting. The bore diameter, concentricity of the outside diameter and axial float of the end register faces are important features which not only affect the accuracy of mounting on the gear cutting machine, but also the truth of the final gear assembly. They also constitute the datum surfaces on which the resultant accuracy of the gear tooth elements depends.

Position Measurements

(*a*) *Comparative methods of measurement.* The measurement of the adjacent and cumulative spacing errors may be determined by intercomparing the pitches of the individual teeth or by direct measurement, using some form of indexing mechanism. With the former, the method basically consists of measuring the departures in circular pitch of the adjacent teeth relative to the pitch of one tooth which is selected as a datum.

In the Carl Zeiss gear measuring machine, illustrated in Fig. 1, the gear to be tested is mounted between the machine centres and the measuring unit is located on a compound slide which is free to move in both the radial and tangential directions relative to the pitch circle diameter of the gear. Two feeler points are arranged to contact similar flanks of adjacent teeth in turn, and any change in their separation due to variations in adjacent pitch are indicated directly by means of a precision indicator. This machine can also be used for the measurement of base pitch, variations in tooth thickness and concentricity of the tooth flanks of spur, helical, bevel and wormwheel gears. Its maximum diametral capacity is approximately 15 inches.

1. "The Tools and Techniques for the Production of Precision Gears"—"The Tool Engineer" Jan/Feb, 1946.

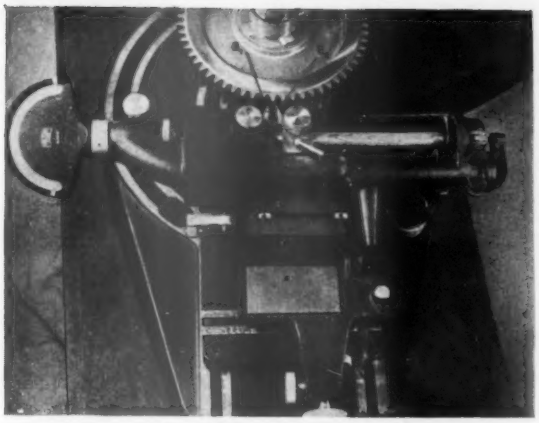

Fig. 1. Carl Zeiss gear measuring machine.

The same principle is also applied in the Maag design of circular pitch gauge. This instrument, which is of portable construction, receives its location from the gear external diameter. Thus the effect of any eccentricity of the external diameter relative to the gear axis is quite clearly included in the measurement.

For both types of measuring instrument the cumulative spacing error of each set of tooth flanks is derived by summation of the errors in the successive pitches. The main weakness of this system of measurement obviously lies in the summation process involved in arriving at the final result and a high degree of accuracy must, therefore, be obtained for each individual pitch reading.

Portable types of pitch comparators, employing the same principle, are extensively used for the measurement of marine gears. Basically they consist of two stylus balls each forming part of a simple lever assembly which, in turn, is attached to a light alloy frame. This type of gauge receives its radial location from the top surface of the gear or alternatively from a register band machined on the end face of the gear. The gauge is arranged to span several teeth and, in this instance, the cumulative pitch error is derived by summation of the variations in the successive span readings. The accuracy of the final result is dependent on the number of span readings, the finish of the tooth surfaces, the sensitivity and repeatability of the gauge, the accuracy of the locating surfaces, thermal change during measurements and the skill of the operator. In view of these remarks it is not surprising to find that inspecting authorities with experience of this work treat the results obtained for cumulative error with some reserve. The problem is one which, in the Writer's opinion, calls for a different method of approach by eliminating the manual operation of the gauge.

(*b*) *Direct angular methods of measurement.* In order to measure directly the spacing of the teeth in relation to their nominal angular position, means must be provided for rotating the gear accurately through angular intervals of 360/N, where N is the number of

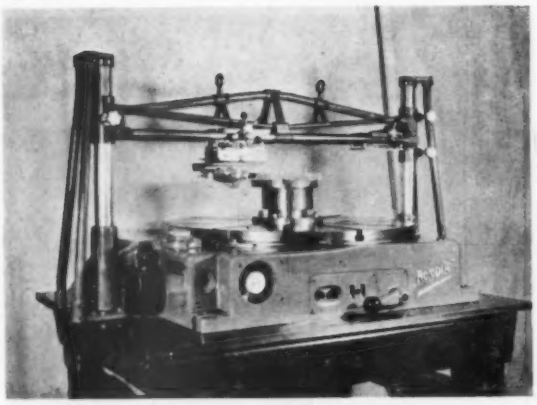

Fig. 2. Precision rotary table.

teeth in the gear. For gears up to about 30 inches in diameter it is customary to use a mechanical indexing mechanism or optical measuring device, such as a precision rotary table, illustrated in Fig. 2. This table, which is manufactured by Societe Genevoise d'Instruments de Physique, incorporates a circular divided scale some 20 inches in diameter and a microscope which enables the angular movement to be set to one second of arc. The overall accuracy of this equipment is within $\pm$ 2 seconds. Whilst the table was primarily designed for use with the firm's range of precision jig borers, it has been successfully applied in the Laboratory to the measurement of gears both internal and external. The gear to be examined is first set concentric with the axis of rotation and the variation in tooth spacing, relative to the nominal angular movement, is registered on a precision dial indicator attached to the rigid tubular frame which spans the table. The measuring unit is located in a precision slide and can be readily retracted from the tooth space before the gear is rotated through the next nominal pitch movement. Other manufacturers of horizontal rotary tables follow the same general pattern as that shown in Fig. 2, in which there is no provision for precision slides or indicator support brackets. To facilitate direct gear pitch measurement it is suggested that there is a need for a self-contained instrument incorporating both radial and tangential measuring units. In addition, the horizontal form of table is preferred to its vertical counterpart, as the gear can be located directly on the surface of the table, thus avoiding the use of precision mandrels.

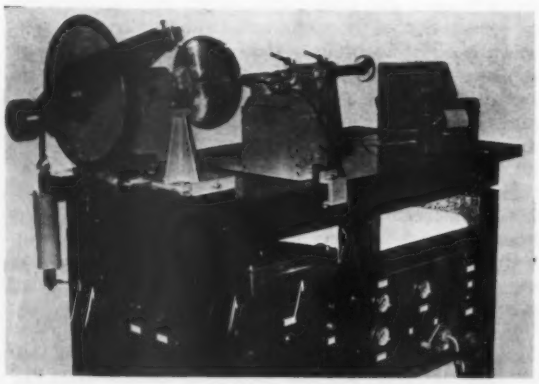

Fig. 3. Converted N.P.L. gear testing machine.

(*c*) *Automatic Indexing Mechanism.* Measurement of gear pitch errors is a relatively slow and tedious process even when carried out under the most favourable test conditions. As the measuring cycle is repetitive there is no reason why the complete sequence of operations should not be carried out automatically. Our initial approach to this problem has been to mechanise the original design of N.P.L. gear testing machine and Fig. 3 shows the machine after conversion to automatic action. With the machine in its original form it was customary to employ two operators, one working the sine arm and the other operating the indicator and recording the results obtained. In the modified design the machine movements are carried out pneumatically, using short stroke air cylinders for each operation, and the correct sequence is obtained by a cam shaft operating a number of air valve controllers. A pneumatically operated counter, preset to the number of teeth on the gear under test, automatically stops the machine at the completion of the test. The errors in tooth spacing are transmitted via a miniature gauging head to a Teledeltos chart recorder.

Using the original machine, a gear having 100 teeth may take about four hours to test, but with the modified design the complete test is carried out automatically in about half-an-hour and an operator is only required for the initial setting up of the gear on the machine, a matter of a few minutes.

Tooth Profile

There are many ways of measuring errors in tooth form and machines employing the base disc principle are considered to be the most suitable for medium size gears. One well known example, illustrated in Fig. 4, is the P.H. 60 machine manufactured by the Maag Gear-Wheel Co. It will accommodate spur and helical gears from two inches to 24 inches and the deviations from the nominal involute are graphically represented by a mechanical design of chart recorder, at magnification ranging from 400X to 1,000X. Whilst a new base circle disc is required for each size of gear, this is not considered to be a serious disadvantage in view of its relative simplicity and ease of operation. The sensitivity of the machine is such that variations of 0.0001 inch can be accurately recorded. Other manufacturers of this class of machine include Carl Mahr, Carl Zeiss and the Illinois Tool Works, U.S.A., but unfortunately there is no machine made in this country comparable to that shown in Fig. 4.

The involute recording machine, illustrated in Fig. 5, and made by Carl Mahr, is of the adjustable base circle design. It incorporates a master base disc

sector and a special linkage mechanism by means of which it is possible to generate any involute curve within the machine capacity of 16 inches. The need for a special base disc for each diameter of gear is, therefore, eliminated. This type of machine was also manufactured by Carl Zeiss pre-war and a present-day example is the No. 12M machine produced by the Fellows Gear Shaper Co., U.S.A., but once again there is no British equivalent.

For the measurement of large gears recent developments include the portable recording instrument, Fig. 6, designed and made in the Laboratory. This instrument makes use of the fact that in large gears the involute profile closely approximates to the basic rack form. It has been designed to record the departures of the tooth profile from a straight datum line rather than deviations from a nominal involute, which is the conventional method used for gears of smaller diameter. Referring to Fig. 6, the instrument consists of a tee-shaped base-plate which is located on the gear under test by means of three adjustable ball-ended legs resting in the appropriate tooth spaces. The recording mechanism shown midway between the locating balls is mounted on the lower end of a precision slide which is arranged to move in a plane normal to the gear axis. In operation the indicating stylus, in contact with the tooth surface, records on a smoked glass plate the departures of the profile from a straight line at a magnification of 10. Subsequent optical enlargement of the smoked glass plate record provides an overall magnification of 500. The trace is then compared at the projector screen with a master diagram drawn to the same scale of enlargement. The instrument may be used purely as a comparator for recording changes in tooth profile due to wear or, alternatively, for direct measurement.

The degree of repeatability of the recording mechanism is illustrated in Fig. 7, by the two tooth traces taken at the same instrument setting on a helical gear, diameter 27.7 inches. The variations from the nominal involute are determined in relation to the straight datum line and the overall accuracy of measurement is estimated to be about 0.0001 inch.

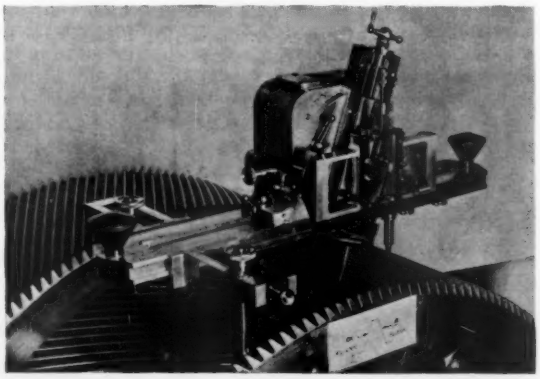

Fig. 6. Portable recording instrument designed in the Mechanical Engineering Department Research Laboratory, D.S.I.R.

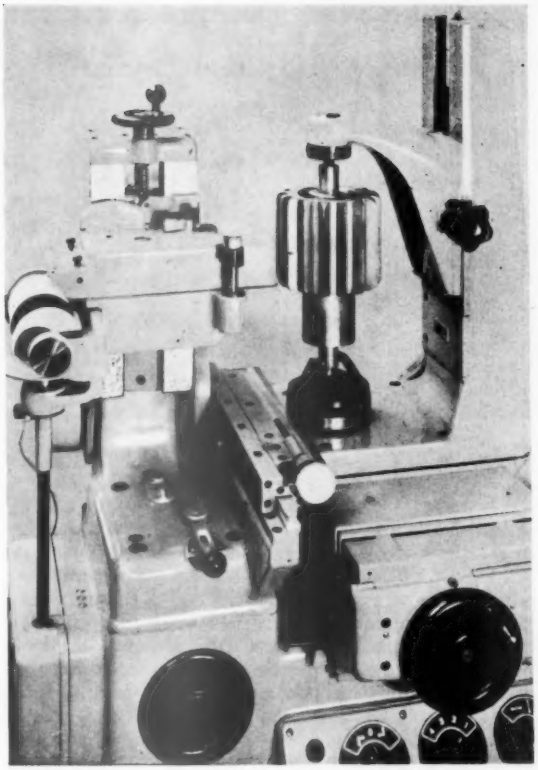

Fig. 4. The Maag P.H.60 measuring machine.

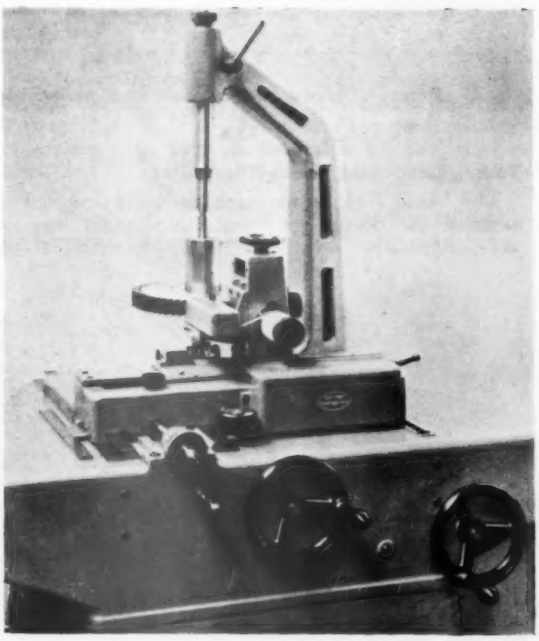

Fig. 5. Involute recording machine by Carl Mahr.

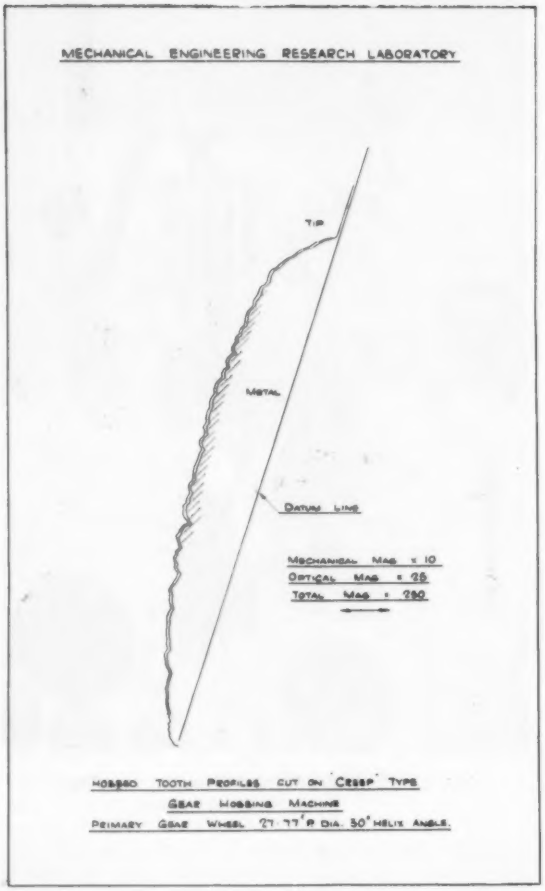

Fig. 7. Degree of repeatability of recording mechanism.

Tooth Lead and Axial Pitch

The Maag P.H. 60 machine has been designed to measure the departures from the nominal lead in addition to the measurement of errors in tooth profile. To achieve this, the linear traverse of the measuring unit parallel to the gear axis is related to the rotation of the base discs by means of a precision circular scale which is preset to the base helix angle of the gear. The traverse speed is controlled by a four-speed motor drive built into the instrument bed. The errors in lead can either be observed during measurement or recorded directly on chart paper. The maximum traverse length is about six inches.

The Orcutt lead measuring machine, illustrated in Figs. 8 and 9, is a single purpose machine designed specifically for the measurement of lead errors. The lead generating mechanism consists of a precision sine bar table attached to a horizontal slide on which the indicator unit is located. During traverse of this slide, the sine bar rotates a master steel disc, integral with the machine headstock spindle, by means of a friction bar or steel tapes. The machine which is manually operated is of the horizontal type and the errors in lead are registered on a dial gauge; there is at present no provision for recording the results. It is of robust construction, easy to operate and is capable of measuring errors of the order of 0.0001 inch.

On marine gears, the tooth lead is controlled indirectly by measurement of the axial pitch or helix angle. Attempts have been made to measure the helix angle, but to date have not proved very successful and similar difficulties arise when trying to establish a reference line for the measurement of axial pitch. In the Writer's opinion the only instrument which has met with any real success is the N.P.L. type of axial pitch gauge.

Meshing of Gears

Detailed examination of every gear element would be a major task if applied to all gears and for the majority of gears produced, it is usual to apply some form of functional or composite test. One of the simplest functional tests used consists in mounting a pair of mating gears at the correct centre distance and rolling them together by hand. The equipment required for this purpose consists of a cast iron bed with one fixed and one adjustable spindle which are set in correct relationship by means of a graduated scale attached to the bed. This test ensures that the gears will run at the correct centre distance with

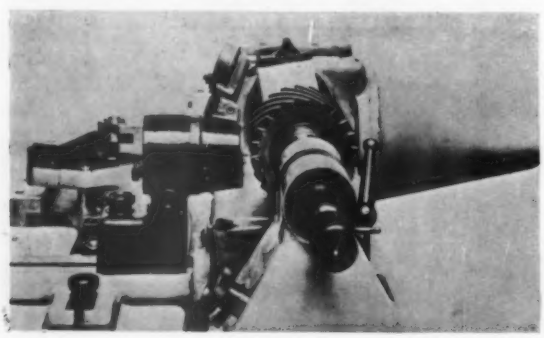

Fig. 8. Orcutt lead measuring machine.

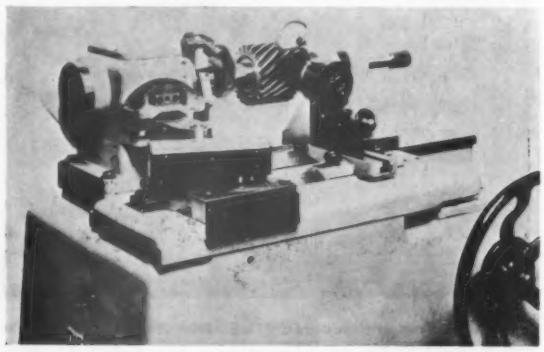

Fig. 9. Orcutt lead measuring machine.

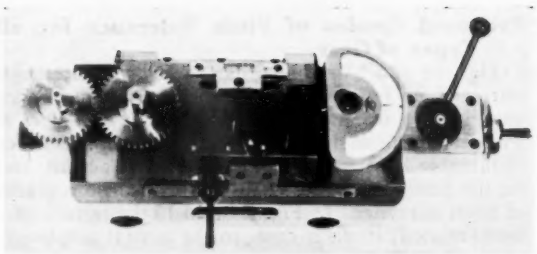

Fig. 10. Rolling gear tester.

suitable backlash and by judging the feel of the gears when rolled together by hand, it is possible to assess the smoothness of the tooth action.

The well-known Parkson type of mesh tester is a further development of this basic idea. In this case, the gear under test is spring loaded into contact with a master gear of known accuracy and the variations in centre distance, which arise during rotation of the two gears, are registered on a dial gauge or recorded on a circular form of chart. Recent developments in this field include a complete range of rolling gear testers made by J. Goulder & Sons Ltd., and the smallest size, suitable for instrument gears, is shown in Figs. 10 and 11. Considerable thought has been given to the design of these machines in regard to ease of assembly, the provision of fixtures for testing all types of gear, accuracy of the essential parts, quality and overall general appearance. Provision is made for recording or direct indicator readings of the variations in centre distance. This type of machine is widely used in gear cutting departments for controlling the overall accuracy of gear production. It provides a direct measure of eccentricity or runout, departures from the designed centre distance when the gears are operating in close mesh and a general indication of errors in adjacent pitch and profile arising from dual flank contact of the mating teeth.

In some applications, however, a direct measurement of the variations from uniform angular transmission is required. This is a much more difficult problem and a completely satisfactory method of measurement has not yet been evolved. One method of approach has been the development of single flank testing machines and a machine incorporating many novel features was designed by Dr. K. Bürger at the National Institute of Technical Physics, Berlin, during the period 1937 to 1940. It is the predecessor of the instrument illustrated in Fig. 12, which was constructed in Minden, Germany, under a D.S.I.R. research contract in 1946. In this machine the variations from uniform transmission of two gears, one a master gear and the other the test gear, is achieved by relating the motion of the gears to that of two friction discs which rotate together without slip. The relative change in angular displacement between these two discs gives rise to small oscillations of the test gear which are a measure of the errors in gear transmission. In the present instrument, the small variations are transmitted by an inductance type pick-up to a chart recorder.

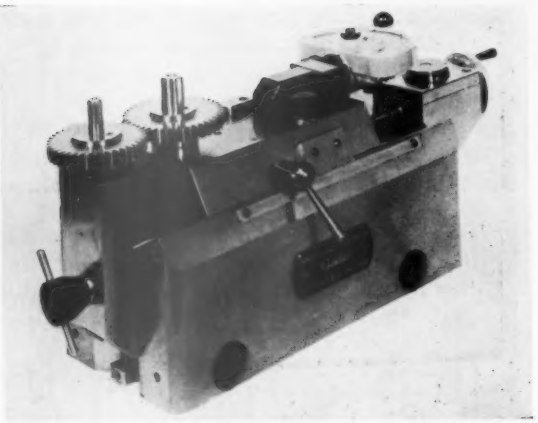

Fig. 11. Rolling gear tester.

Using this method of test, it is possible to display on one chart all sources of error which contribute to variations from uniform motion. Fig. 13 shows the conventional form of pitch error graph and profile record obtained from direct measurement of the gear elements, together with the single flank recording of the errors in relative motion. The amplitude and form of the cumulative errors in circular pitch are clearly visible in the composite record, and the expanded record over one pitch movement shows the effect of errors in tooth profile. Whilst the present instrument is suitable for laboratory use, it is suggested that some form of direct functional test, as distinct from analytical measurement of the individual tooth elements, is preferable for certain types of precision cut gears.

One problem common to both dual and single flank testing instruments is the supply of very accurate cylindrical master gears. Experience shows that it is extremely difficult to achieve the required standard of accuracy as facilities available for this class of work are, in general, very limited. An alternative

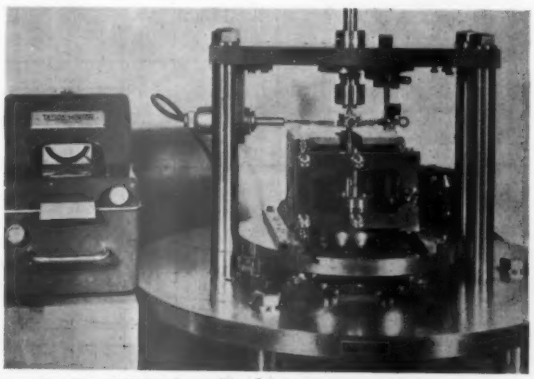

Fig. 12. Gear tester constructed in Minden, Germany, in 1946.

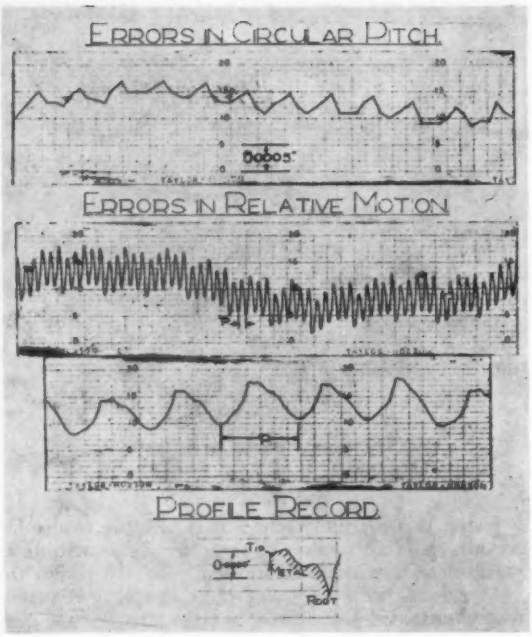

Fig. 13. Conventional form of pitch error graph and profile record obtained from direct measurement of the gear elements, with single flank recording of the errors in relative motion.

approach to this problem has been to use a master gear rack in place of the cylindrical gear and a rack type of dual flank tester is now being produced by the Eastman Kodak Co., Rochester, U.S.A.

Proposed Grades of Pitch Tolerance for all Types of Gear.

Figs. 14 and 15 are records of pitch measurements obtained on gears submitted to the Laboratory for examination over the past six years. The object of these records is to show the standard of pitch accuracy obtainable by existing methods of manufacture, and on the basis of these results to establish various grades of pitch tolerance. In Figs. 14 and 15 the results have been related, in each case, to the actual arc length of measurement and cover both errors in the adjacent and cumulative pitch. The family of curves based on these measurements cover six grades of accuracy and the suggested formulae are given below.

Grade	*Pitch error* (*unit* 0.0001 *inch*)
A	$1.2\sqrt{Lm + 1}$
B	$2.2\sqrt{Lm + 0.1} + 1.3$
C	$3.3\sqrt{Lm + 0.25} + 1.8$
D	$4.8\sqrt{Lm + 0.5} + 3.6$
E	$9.5\sqrt{Lm + 1} + 4.5$
F	$20\sqrt{Lm + 1} + 10$

where Lm is the length of arc of measurement in inches.

Grade A represents the highest standard of pitch accuracy and is intended to cater for master gears and precision indexing gears. This type of formula is similar to that used in the British Standard Specification for marine gears (B.S. 1807 : Pt. 1, 1952). It provides for close control of the adjacent and short span errors, so essential for the majority of gear applications.

It has been suggested that the value of the adjacent pitch error is related to the diametral pitch and the formulae should, therefore, include a D.P. factor. This point has been investigated by analysing the measurements obtained on a large number of master gears and shaving cutters. The form of the two

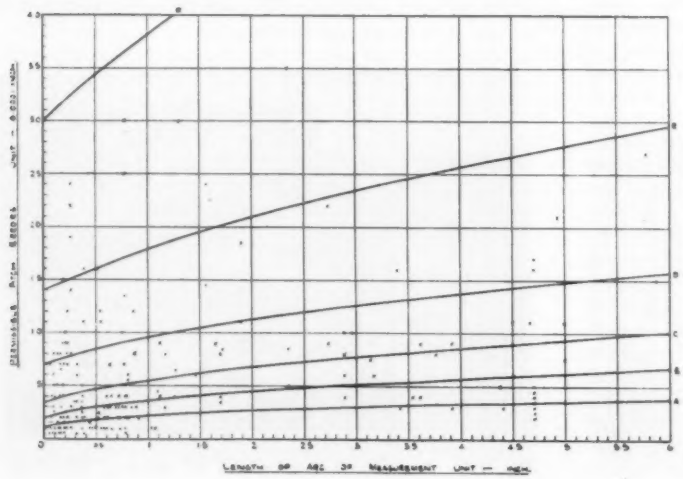

Fig. 14. Record of pitch measurement.

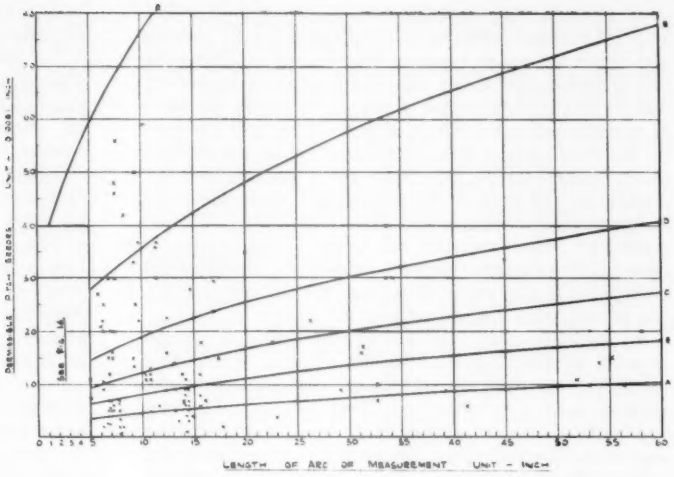

Fig. 15. Record of pitch measurement.

curves given in Fig. 16 indicates that the adjacent error is largely independent of the range of D.P. This analysis covers gears and cutters finished by grinding, but the effect of other finishing processes such as hobbing and shaving still requires to be investigated. Experience shows, however, that the adjacent pitch errors of shaved gears closely follows the average error of the shaving cutter, which supports the view expressed above.

Surface Finish of Gear Teeth

The assessment of the surface texture of engineering components is covered in some detail in B.S. 1134 : 1950. In this specification the surface texture is sub-divided as follows; primary texture which results from the normal action of the tool in the production process, and secondary texture or surface waviness which results from imperfections in the performance of the machine and tools. It also states that the terms " primary " and " secondary " relate only to the intrinsic nature of the components of texture to which they refer, and have no bearing on their relative magnitude or importance.

On marine gears produced during the late War breakdown of the gears in service was, in some instances, due to excessive undulations imposed by errors in the gear hobbing machine. Failure of the gears by pitting or scuffing had occurred on the high spots of these undulations. The theory of gear tooth undulations, including methods of measurement and subsequent analysis, has been adequately covered in previous papers in which due recognition is given for the fundamental work carried out at the N.P.L. during the period 1939-1949 and more recently at the M.E.R.L. With the gradual improvement in the accuracy of gear hobbing machines, the provision of temperature controlled rooms and the introduction of post-hobbing processes such as shaving and lapping, it is now possible to control the magnitude of these undulations to within 0.0001 inch and consideration is now being given to the measurement and assessment of the finer surface irregularities, referred to as primary texture in B.S. 1134.

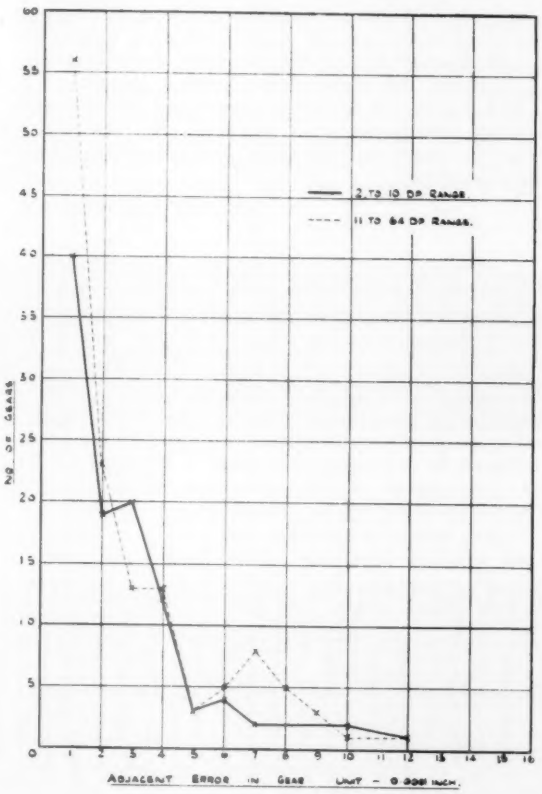

Fig. 16.

In general, the measurement of the finish of flat and cylindrical surfaces is a relatively easy process and there are many types of instrument available for this purpose. Of these, the stylus type of recording instrument incorporating a sharp exploring probe is in widespread use both in this country and abroad. As the exploring probe is traversed along the surface under examination, its movement normal to the surface may be amplified mechanically, pneumatically or by electrical means and finally recorded. Whilst graphical representation of these irregularities is essential for research purposes, some form of numerical assessment is also required so that the degree of finish can be specified and quoted on drawings.

A peak-to-valley value derived from a graph appears at first sight to be the obvious method of specifying the degree of finish. In practice, the method used is to draw two lines through the crest and valleys of the recorded length of chart; the separation between these lines being a measure of the finish. There is at present no universally accepted rule for doing this and the positioning of each line is usually left to the discretion of the observer; this also applies to the length of record selected for measurement. This arbitrary method of assessment is not suitable for general application, and its direct measurement by means of a scale and pointer instrument has so far proved unsuccessful.

In this country the preferred measure is the Centre-Line-Average Height and it is defined in B.S. 1134 as the average value of the departure of the profile from its centre line, whether above or below it, through the prescribed sampling length. The C.L.A. value can be easily represented by scale and pointer instruments and, provided the reading is related to the finishing process, it forms a useful index for general use.

The Talysurf instrument, which incorporates means for recording and indicating the surface irregularities, is the most widely used instrument in this country. The instrument traverse length is closely 0.25 inches and magnifications of up to 100,000X can be achieved. In common with other instruments of this type it cannot be easily applied to large gear wheels. In addition, the curvature of gear tooth surfaces presents difficulty in establishing a convenient reference datum for measurement.

The measurement of the finish of components which are not readily accessible to stylus recording instruments can, however, be carried out through the medium of plastic replicas. Fundamentally, the process consists in taking a plastic replica of a machined surface on a strip or film of cellulose acetate and the impression thus obtained is measured directly by means of a stylus recording instrument. Sometimes it is more convenient to make a cast of the gear tooth space using a material such as "Marko" resin and to measure the surface of the cast thus obtained. The records in Fig. 17 were obtained in this manner and represent typical finishes produced by hobbing and shaving on a helical gear four inches in diameter. As would be expected the magnitude of the irregularities on the shaved gear is less than of those of the hobbed gear and the C.L.A. values are eight and 28 respectively.

Future Developments

The manufacture of gear measuring equipment in the United Kingdom is carried out on a relatively small scale when compared with Continental sources of supply. There are, of course, many firms in this country who are capable of producing a wide range of precision measuring instruments but none, in fact,

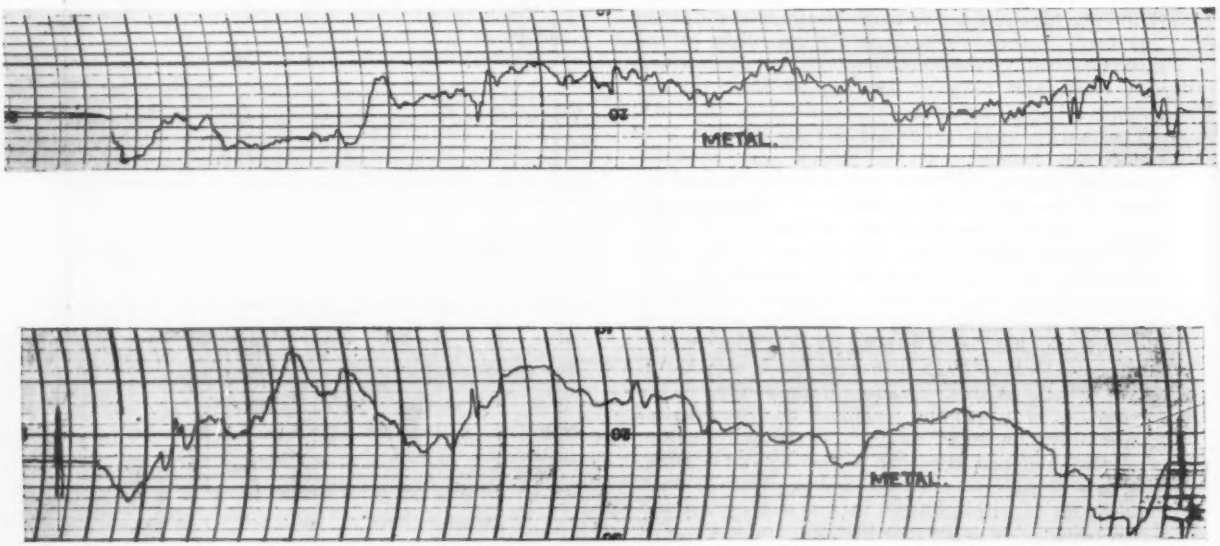

Fig. 17.

specialises in the production of instruments for controlling the accuracy of gears. It is suggested, therefore, that an extension of these facilities to cater for gear requirements deserves serious consideration. Regarding future developments, the following ideas are suggested:

1. The need for a cheap and compact form of recording instrument which can be used in a measuring instrument or applied to a machine tool with the same ease as a dial indicator. Direct recording methods of measurement provide a permanent record of test results and the chart enables the result to be seen at a glance.
2. Direct measurement of adjacent and cumulative pitch errors. In this field there is scope for a manually operated instrument in addition to an automatic version.
3. Recording type of instrument for the measurement of errors in tooth profile and lead of spur and helical gears.
4. Development of a single flank testing instrument suitable for inspection departments.
5. Continuous method of measuring errors in the lead of worms and gear cutting hobs.

Acknowledgment

The Writer wishes to thank the firms who have assisted in providing material for the paper, which is published by permission of the Director of the Mechanical Engineering Research Laboratory.

DISCUSSION

Mr. Patterson (Ford) asked for Mr. Timms' views on the composite method of gear checking as against the individual element method.

Mr. Timms, in reply, said it depended on what they wished to do. In determining the accuracy of a gear hobbing machine the conventional form of composite test would not give a direct indication of the errors in the machine itself. For that type of work a measurement of the errors in circular pitch, helix angle and tooth profile of a test gear was desirable. If, on the other hand, they were concerned with producing gears in quantity, there was scope for the dual flank composite method of test in which the accuracy of the production gear was related to that of a master gear. As mentioned in the paper, the method of test had certain limitations but it did provide some measure of production control. Instruments employing the single flank principle of measurement were suitable for laboratory and experimental work, but had not yet reached the stage where they could be readily applied in the workshop or inspection department.

Captain E. Stewart (representing Engineer-in-Chief, Admiralty) paid a tribute to Mr. Timms, on behalf of the Admiralty, as well as his personal tribute, for the excellent and interesting lecture, and for his efforts on behalf of the Admiralty Vickers Gear Research Association. A lot of the work done since the War in the advancement of large marine gears had been due to Mr. Timms' efforts in the design of accurate measuring instruments. It would be safe to call him an " Architect of Accuracy ".

The Admiralty had had some success in its large gear work since the War and, against considerable odds, had produced a 30,000 horse-power all-hardened gear which it was hoped to have on test very shortly. From measurements to date it seemed to be a very accurate gear. The larger the gear and the more hardened it was, the less it was susceptible to adjusting itself by "running in". It was with these big gears which were hardened, that it was so very important to have the instruments which Mr. Timms had mentioned in his lecture.

In connection with Mr. Timms' last paragraph he made a plea for the demand for British instruments by the gear manufacturers, because they would not get these instruments unless the gear manufacturers asked for them. It was rather like the case of people who would not be X-rayed because they feared there might be something wrong with them. People also sometimes did not like to be told that their " masterpiece of engineering " was not as accurate as they had previously believed!

Mr. Timms thanked Captain Stewart for his very kind remarks and for the facilities which the Admiralty had provided in the development of gear measuring equipment.

Mr. A. H. Orcutt (Gear Grinding) said Mr. Timms' reference to future developments had given them a lead as to the lines to follow. He had spoken of the need for a cheap, compact form of recording instrument and had also asked, in paragraph 3, for a recording type of instrument for the measurement of errors in tooth profile and lead of helical gears.

Mr. Timms had spoken of the need of a single flank testing instrument suitable for inspection departments. Presumably that meant two flanks kept in contact where there was backlash, but the flanks were kept in contact. Would not a better way of approaching that be to use a master rack with a straight-sided tooth? This was easier to produce than a master gear, which was always a difficult job.

Was Mr. Timms talking of instruments for laboratory purposes or for workshops? Had he had any experience with the Talymin, which was similar to the Talysurf except that it would have both axial and right-angle movement?

Mr. Timms, in reply, said he felt that the available recording instruments, whilst good and accurate, were unduly expensive. In order to popularise the recording type of measurement, it was necessary to bring the price down so that it was at least comparable with a precision type of dial gauge. It should not cost more than £25 to £50 and one could then apply it directly to any type of measuring instrument.

When enquiries were received at the Laboratory for instruments for the measurement of tooth profile and lead, there was no alternative, at present, but to refer them to firms abroad. Item 3 in the paper therefore referred to the need for the development in this country of a precision tooth profile and lead measuring instrument.

Mr. Orcutt asked whether it should be a combined instrument.

Mr. Timms replied that it could be either combined or single-purpose depending on the customer's requirements. He felt that any instrument made should be so designed that it could be applied equally in the workshop or in the laboratory.

The idea of using a master rack in place of a cylindrical gear was quite interesting. Mr. Timms hoped in the next six months to have an instrument available of that type.

The Talymin recording unit was being used extensively within the Laboratory and with very satisfactory results.

Mr. Yoxen (W. H. Allen, Sons & Co. Ltd.) said he agreed with Mr. Timms about the need for a checker of the P.H. 60 type to be made in this country, but the increasing interest in epicyclic gears meant that there was also a demand for a machine to check internal gears, with reference to the profile and the helix. The P.H. 60 was a very good machine but it had a disadvantage—it was limited when checking internal gears beyond about 12 inches in diameter.

If one of these cheap recording instruments were produced, he hoped it would not be temperamental but would be stable for quite a long while.

Mr. Timms, in reply, said he was only using the P.H. 60 as an example, and he was merely pointing out that there was no comparable instrument made in this country. Whether the range should be widened was a matter for the user to determine. When speaking of a cheap type of recording instrument, he meant cheap without reduction in accuracy.

Mr. Orcutt asked whether Mr. Timms had in mind a first-class indicator, or a complete recording instrument. If so, was he not thinking of something necessarily complicated—and, if so, the price could never be brought down to £25 or £50.

Mr. Timms, in reply, said that for magnifications up to 500 to 1, or perhaps 1,000 to 1, a mechanical lever system would operate as effectively as any other mechanism, whether pnuematic or electrical. With mechanical lever systems for chart recording, the highest magnification would be about 1,000 to 1, but excessive friction in the lever system may reduce the accuracy of measurement. Whether the required recording instrument could be made for £25 or £50 would depend to some extent on the quantity made.

With regard to the commercial development of instruments he considered that this was the responsibility of the gear manufacturers and the first requirement was a well equipped instrument section for development work. The association of a gear firm with a firm specialising in the production of precision instruments was highly desirable. Such associations existed on the Continent and it was important that they should exist in this country. In addition, the Laboratory was prepared to advise on instrument design and on appropriate standards of accuracy.

Mr. Walker commented on the method, illustrated in one of the slides, for checking gear tooth forms by measuring the departure of the profiles from some convenient straight line in a transverse plane and comparing the results with those obtained by calculations. The need for these laborious calculations could be avoided if the straight line was arranged to coincide with the tangent to the base helix. What were Mr. Timms' views on this?

The second point related to the formulae for permissible pitch errors. It seemed that the longer one lived the more one was made to appreciate the versatility of the square root of a function—it was employed in the British Standard for Gear Hobbing Machines to determine the required diameter of a feed screw or the number of teeth in a table worm-wheel, and now it was found that permissible pitch errors were tied up with the square root of the length of arc of measurement. Was there any fundamental reason for adopting the square root expression? Would not a linear relationship fit the bill just as well?

Mr. Timms, in reply, dealt first with the point about measurement of profile in a transverse plane as opposed to measurement along the base tangent. On a gear which might be 10 feet in diameter, measurement along the base tangent was a difficult problem, even though it was relatively easy on small gears. On a 10 ft. diameter gear, the departure of the tooth profile from a straight datum line only amounted to. 002 inch and he thought that, instrumentally, the method suggested in the paper presented the easier problem.

Referring to the formula quoted in the paper for pitch measurements, experience showed that it agreed very closely with design requirements and also with the actual pitch errors resulting from existing manufacturing processes. A simple linear expression was not suitable for short span or adjacent pitch errors.

Mr. A. Sykes (David Brown & Sons), who supported Captain Stewart's comments on the debt owed by the country to Mr. Timms, both from the point of view of the gear makers and the point of

view of the gear users, said that any one who saw Mr. Timms' department would realise that for him gearing was not a sideline but a major consideration.

The reason why not many of the more elaborate testing instruments were made in this country was that the development cost of such apparatus was high and the demand was not usually very large. Although Mr. Timms had spoken of an instrument selling for £50 or £60, he had also mentioned the P.H. 60 instrument, which sold at over £2,000. Mr. Timms had shown in Fig. 1 an instrument for testing pitch of a very simple type, made by Zeiss. There were similar adaptations of the same instrument in use in this country. One of the difficulties with that type of instrument was that it had a fixed pointer as well as a moving pointer connected to a dial, and there was a tendency on the part of the operator to strain the fixed pointer. There were methods for registering whether it was being strained as the instruments were being used.

Mr. Timms illustrated the apparatus which he and his department had devised for measuring profiles of large gears. One complaint made against that instrument was that it was said to be slow in use, particularly because it required rather elaborate calculations to compare the graph produced with what was required.

An American instrument, which seemed to operate similarly, and was known as the Vinco, was said to be more simple. It was a device by General Electric Company. He wondered why Mr. Timms had not used his instrument on the same lines. The American instrument measured vertical and horizontal co-ordinates. Why could not Mr. Timms convert his instrument for use in the same way?

He had seen the automatic instruments for pitch testing which Mr. Timms had. This instrument could find uses outside the laboratory and he thought it possible to adapt the same type of instrument for the measurement of hobs, which was even more tedious than measuring gears and shaving cutters.

He supported Mr. Timms' remarks about the application of the square root formula to the allowable errors in gears. The square root formula might not be what was desirable but it was what was practicable of attainment.

Mr. Timms, in reply, said he knew he would get into hot water for suggesting that there ought to be more facilities in this country for the production of precision gear measuring instruments! Similar problems arose before the late War with the production of precision optical instruments and several firms could now supply this type of equipment. His Laboratory was always prepared to assist any firm willing to take on this venture, both in giving them advice on their designs and in carrying out tests on prototype equipment.

Mr. Sykes had referred to the relevant and comparative costs, but when mentioning £50 he was referring to a simple recording unit as attached to an instrument and not to a complete instrument.

He agreed with Mr. Sykes that the complicated calculations on their portable recording machine were a disadvantage. Although he had never used the Vinco instrument, he was familiar with it. The essential difference was that the Vinco measured from point to point down the tooth, whereas their own type of instrument gave a complete record along the tooth profile.

He could modify their instrument to give direct measurement, but he was not sure that this was the right method of approach. There must be a simple way out of calculating the variations of the involute profile from a straight datum line as against their present rather lengthy method of approach, and once that had been achieved the main disadvantage would have been removed.

Mr. H. Parkinson (J. Parkinson & Sons), referring to the method of recording, asked which method Mr. Timms found most suitable for making a chart record with magnifications of about 5,000 to 1. One of the difficulties with such chart recorders arose from the friction of the pen in making the chart. There were other types of chart, but if they were to use a mechanical lever system making the magnification, might it not also be possible to adopt the type of pen and chart used in some instruments where friction was virtually eliminated? In the chart recorder used with the Talymin gauge head friction was negligible and this chart recorder was extremely sensitive. He had not had experience of mechanical lever types where the response was as sensitive as with the chart recorder used with the Talymin gauge head.

There was a need in this country for the types of instrument which Mr. Timms had described. The rolling type of test, one type of which was used on machines made by Mr. Parkinson's company, was useful in a workshop and was originally accepted more as a workshop than as a laboratory instrument, but to some extent it had been translated to higher spheres.

That type of test showed errors but on analysis the results were only partially helpful and were not the complete answer. While it needed a workshop test, the gear industry also needed tests of the laboratory type or the master type, to be supplied by the instruments which Mr. Timms had mentioned.

Another problem was the measurement of individual pitch errors and of cumulative pitch errors, and he was glad that Mr. Timms had pointed out the divergence which could exist from the true cumulative pitch error after taking a series of individual pitch comparator readings and plotting them. A high order of accuracy was required in taking individual pitch comparator readings and it was also important that the fixed and moving points of the comparator both made contact with similar points of the gear teeth; on a spur gear these points would be at the same radius and on the same plane at right angles to the axis of a spur gear. If this was not done, other factors such as slight variation in tooth profile or in surface finish affected the reading. In other words, the method was useful to some extent but could not be relied upon to a high degree of accuracy in assessing the accumulated error.

Mr. Timms had shown the use of the optical rotary table and other methods. What other methods were there of providing a good test of accumulated errors? He had always found that a rather difficult subject. Could Mr. Timms enlighten them further upon it?

Mr. Timms, in reply, said that a first-class recording instrument, designed mechanically, required very fine workmanship of the watch-maker quality for the pen movement itself. It was very very annoying, when using an instrument, to find that the pen did not mark on the chart paper, but these difficulties could be overcome provided that sufficient care was given in the design and manufacturing processes.

He agreed that the dual flank method of test was useful for workshop and inspection purposes, provided that its limitations were appreciated.

As for direct methods of measuring cumulative pitch, one method of approach was to relate it to a precision rotary table. There were other methods of approach and the sine arm method, referred to in the paper, was basically sound.

Mr. R. M. MacArthur (Power Plant Co. Ltd.,) said Mr. Timms was the leading authority on gear metrology in this country, and he was conservative enough to think that that meant the world, even though we may not have exploited our knowledge commercially as much as we could have done.

In such instruments as those under discussion, one of the basic problems was to put in general terms the problem of converting linear to circular movement or *vice versa*. The usual method was to employ a disc rolling under pressure on a straight edge or tapes and a drum. For some years efforts had been made to develop precision racks for the job. Had any success been achieved in that direction?

Mr. Timms, in reply, said that a lead measuring machine incorporating steel tapes and a friction disc was available in the laboratory and its overall performance was very satisfactory. A master rack and pinion had previously been used in the machine but it was difficult to eliminate small residual errors associated with this form of drive.

Dr. Darlington (Metropolitan-Vickers Electrical Co. Ltd.) said he wanted to speak for the class of gear makers who were making the larger type of gearing, which could not necessarily be dealt with by the machines shown during the lecture. The rotopic tables had been mentioned, but they were limited by the weight which could be placed on that sort of instrument. He agreed whole-heartedly with Mr. Timms that good instrument makers were required to provide this equipment, but in addition they required someone prepared to specialise in thinking out this type of machine.

His firm had found, with large turbine components for marine purposes or even for small power station equipment, that the question of matching helix angles and the measurement of axial pitch could not be dealt with adequately by an existing instrument, and in the end they had to do the inevitable and develop one themselves, with the assistance of some of the instrument makers mentioned during the lecture. He felt that cost did not play a major part in such a machine. In fact, they must have wasted £1,000 in the drawing office, making drawings and re-drawing them, bringing themselves up to date with later and better ideas, many of which had been developed in association with Mr. Timms. Therefore, in addition to the need for the measuring instruments mentioned by Mr. Timms, there was a demand that one of these firms should take on the business of making large metrology machines. He was sure that cost would not be a prohibitive feature because, as a percentage of a firm's output over 10 or 15 years, the cost of that machine would be relatively small.

Mr. Timms had also dealt largely with instruments within the factory but from time to time there arose the problem of someone who had run a gear for 20 years and when it was beginning to get noisy he wanted a new rotating element for nothing. Problems also arose with large marine gears where for various reasons—deflection under change of cargo conditions, for instance—there was varying bedding through the gear. While an absolute instrument was fundamentally necessary within the factory, there was also need for a good portable comparator to enable site engineers to measure tooth profile. It was necessary also to deal with surface finish, but that could be done by existing techniques.

Mr. Timms had been approached about the use of his instrument on a marine gear, but the ship was available for only five days in turning round and it was not possible to strip out all the components and wheels and take them to the factory. What was needed was an instrument whose mechanisms were not controlled by gravity, since it might have to be used through a vertical opening in the case to get to the gear.

Such points needed to be thought out by a firm interested in helping gear manufacturers to keep a check not only on their original quality, but also on the quality of their gears throughout their life. Only by a study of the effects of change of design factors on the quality of their products with time could they ascertain whether the design changes being made were in the right or wrong direction. He hoped that Mr. Timms would understand that only lack of time had prevented him from congratulating him more fully on his excellent paper.

Mr. Timms, in reply, said he was glad to hear that costs were not of primary importance! The various problems mentioned by Dr. Darlington largely related to large scale metrology and this aspect of the subject had not been covered in the present paper. The Writer was fully aware of the need for further development in this field and he was always willing to assist firms who had problems of this kind.

The CHAIRMAN (Mr. J. E. Skidmore), expressed the appreciation of the Meeting to Mr. Timms for his very interesting paper, and the proceedings then terminated.

MATERIALS HANDLING

A Series of Case Studies

IN my capacity as Chairman of the Materials Handling Sub-Committee, which is a part of the Research Committee of the Institution, it gives me great pleasure to introduce to you this month the first of a series of Case Studies on Materials Handling. The Materials Handling Sub-Committee hope that this will become a regular monthly feature of the Journal, putting before the members of this Institution some selected good solutions to Materials Handling problems which will be of general interest.

It is our aim to present these Case Studies in such a way as to show the job "before" and "after" the application of an improvement in handling technique, and the capital cost of the installation will be indicated, wherever possible. The benefits obtained from the improvement will also be shown in every report. It will be appreciated that these benefits will not necessarily be savings in financial terms; there will be cases where the economies obtained have been in terms of floor-space saved, or where reductions in labour-time or fatigue have resulted in higher productivity in a manner which would make it diffcult to express cost-saving directly, in pounds, shillings and pence.

It will be our endeavour to ensure that Case Studies are self-explanatory and contain sufficient details to allow the applications described to be applied elsewhere; however, should any reader require further information from the author, he will be able to obtain it by application to the Institution.

I would like to take this opportunity to invite you all to provide the Materials Handling Sub-Committee with Case Studies suitable for inclusion in this series. Our appeals to date have met with a good response, but we need many more studies to maintain this as a regular monthly feature of the Journal for some length of time. Contributions will be published with the name of the author and his Company; however, if preferred, Case Studies can be published anonymously, always providing that the author has obtained the consent of the Company in which the application was originated. Members of the Materials Handling Sub-Committee will be only too pleased to assist authors in the preparation of their Cases and will be prepared to visit prospective contributors, if required.

The importance of giving the widest possible publicity to instances of good Materials Handling practice, as a means of raising the productivity of British industry, need not be stressed to members of this Institution. We hope that this series of Case Studies will serve as a small contribution in this field.

A. G. HAYEK,
Chairman, Materials Handling Sub-Committee.

CASE STUDY. No. 1

Feeding Powder to a Pelleting Machine

FIRM : **Pescomating Enterprises**

AUTHOR : **Development Engineer**

An example of materials handling applied directly to a process.

The Company. *The Company where this example was introduced employs 800 people in its five divisions, each division being involved in entirely different processes. In the immediate post war years, its Plastics Division (150 employees) was the scene of organised production development, undertaken by one individual.*

The Source. *A department was created for the purpose of developing production techniques, including layouts, methods study and process study in its scope, thus co-ordinating the elements of production likely to have the speediest results.*
The department has now grown and undertakes the same function for the group of industries carried on by the Company; and now includes a workshop development section for proving ideas and building new units for assembly, or special machines and process plant. At the time the example was developed no such organisation existed and the equipment was built to verbal instructions by the Works Tool Room.

Approach. *No attempt has been made to distinguish between Work Study, Process Study or Material Handling as an approach to any new job. Only in retrospect do any of the improvements made fall into any useful category, and then only offer a guide for future specialisation, rather than a policy of action for any new job studied.*

The Circumstances. *For convenience of subsequent handling during the moulding cycle, plastics moulding powder is compressed in a pelleting machine into pellets of predetermined weights.*
The hopper of the machine which carried the powder was reciprocated across the fixed die, and was therefore limited in capacity.

The moulding powder could not economically be delivered in any other form than powder in sacks or barrels.

old method

A full barrel of powder was opened by removing the patent toggle operated band which retained a rimmed lid. The machine hopper, which has a powder capacity lasting seven to eight minutes, was filled by hand scoop from the open barrel, and the lid replaced to eliminate dust from the constantly shaking powder.

The whole operation was tedious and produced a health hazard in the form of fine dust which unavoidably arose when the fine powder was disturbed. One man was kept fully employed feeding powder to four machines.

HANDLING

new method

The equipment involved was :

1. A double runway was erected giving a trolley movement in any direction over all four machines, and an area 10 ft. behind them.
2. A simple two-legged stand with a collar of drum diam was erected straddling the machine hopper.
3. A cone with a shutter was made, with its largest diameter the same size and shape as the barrel lid, which enabled it to be fitted to the drum and retained in place by the toggle operated band.
4. A circular band with two spigots at 180°, was clamped around the centre of the barrel.

Procedure. Since the area covered by the trolley extended over the storage area of powder drums a barrel could be prepared on the spot. The lid was removed and replaced by the cone, and the shutter on the small end closed. The clamp was then fixed around the centre of the drum, and the hand operated hoist brought into position. This terminated in a horseshoe bracket with two hooks for engaging in the spigots of the clamp.

The drum was lifted, inverted, and transported; and dropped into the frame over the machine hopper. The lid of the hopper had a rubber hose fixed to its centre, and other end of which was fastened to the small end of the cone.

When the shutter was opened the machine could be started, the motion of the hopper providing the agitation necessary for keeping the powder flowing.

A drum of powder thus erected in five minutes lasted 1 hour and 20 minutes.

Summary of Advantages.

1. Elimination of health hazard.
2. Machine could run longer without attention (10-11 times).
3. No manual lifting of drums to the machine.
4. Saving in operation time (6 hrs./day) available for other work.

Installation. Introduced on a trial and error basis. Once proved on first machine, was extended to the other three and the runway added. This latter piece of equipment was available from an obsolete section of the Works, and did not have to be purchased.

Approx. Cost of other equipment £30 each machine.

Summary. This particular installation was introduced in the immediate post war years, and at the time no modern pelleting machines were available. They are still used alongside more modern machines, and the only change is that a fork lift truck now serves as transporter and elevator for the barrels of powder to all machines, new and old amongst many other jobs.

THE ANNUAL DINNER, 1955

The Annual Dinner of the Institution was held at the Dorchester Hotel, London, on Wednesday, 12th October, 1955, and was attended by over 500 members and guests. The President of the Institution, Sir Leonard Lord, K.B.E., was in the Chair and the principal guests were Sir Brian Robertson, G.C.B., G.B.E., K.C.M.G., K.C.V.O., D.S.O., M.C., Chairman of the British Transport Commission, and Mr. A. B. Waring, Chairman and Managing Director, Joseph Lucas, Limited.

The Loyal Toast, having been honoured, the PRESIDENT proposed the toast of

"*THE GUESTS*"

He said it was his duty to propse this toast but no doubt he would be allowed a little indulgence. It was the first time he had appeared before them as President; they should take a good look at him for he hoped it would be his last appearance! (*Laughter*). He was not a very good President but no doubt he would do for the occasion.

First he wanted to talk to the production engineers present, which was only half the company; the remainder were respectable! (*Laughter*). He could look back over 30 years " in the game " and he hoped he could look forward to a few more years.

Twenty-five years ago his boss, Frank Woollard, signed an order for some transfer machines. That was the easy part of it.

The machine tool makers did not take any real interest at the time in these automatic machines—Archdale's, Asquith's, Alfred Herbert's, Wilkins' and Mitchell's and, to a smaller extent, Ward's, Parkinson's and Churchill's. He did not think they had ever been so busy either before or after, and he was sure they had never lost so much money in so short a time! (*Laughter*). No doubt they learned something from it, but the tragedy was that they did not follow it up.

The advanced machine tools of today could not be obtained from the British machine tool trade. They liked to make old-fashioned drilling machines and milling machines. Some people in this country who wanted advanced machines had to go to Germany, which was a shame. If anybody present had any influence with our machine tool makers, he should tell them to pull their socks up a bit. The trades unions apparently had a solution—to nationalise them; and things could not be much worse if they did! (*Laughter*).

This brought him to the present—that little period between the past and the future. The future of production engineering and, finally, he believed, of England, was in the hands of the production engineers and the scientists. The country had to export to live; that must be a fact. We had an increasing population and we had to export to get the food to feed this increasing population, and even to find money to import coal! That meant that we had to sell abroad things which people wanted, of a design which they would accept and at a price they were prepared to pay. He knew of no way to sell an article to somebody who did not want it or who was not prepared, or could not afford, to pay the price. When we received the money for our exports we had to look at it alongside our costs. Our costs were made up of labour, materials and overheads and—he hated to say it—profits. If competition became too bad, they could forget the profits.

If things became very bad—and they could—they must look to see what could be done. There were several things which could be done. First of all, they could look to their overheads and they could insist that the Government look at their overheads, which were much too high anyway. Then they could look at materials. In the old days of the motor trade, many years ago, people talked about proportional costs, on labour and materials, and these used to be 1 to $2\frac{1}{2}$ or $2\frac{3}{4}$. Today, figures were 1 to $8\frac{1}{2}$ to 10.

Material must be used carefully, and that brought them back to the production engineers. They must all keep this in mind when thinking of machine shops. They should remember that they were only taking off in the shops what they had paid for in the first place, in order to sell it as scrap metal afterwards.

The Right Perspective

They must get the perspective right. They should not look at the great machines which cost £100,000 or £200,000—there were simpler things. Sir Brian Robertson would not put British Railways right by cutting two minutes off the time of the London-Birmingham trains, but he could do a lot of good in the goods yard. That was where he should go—and the production engineer, too, should go further down the line.

When he mentioned a car factory, what did they see in their minds? They saw the assembly line, with cylinder heads, crank shafts and so on. If an automobile engineer were asked to give, quickly, the names of parts which went into an engine, he would mention such things. But there were 200 parts. Those were the big things he had mentioned. What about the remainder? What about the odds and ends—the old milling machine in the corner?

He was serious about this: the big things would take care of themselves. They always did. They should look after the small things; that was where the

savings could be found. Get the work off the floor, get some simple means of taking it from machine to machine; keep it moving, and stop the bottle-neck.

They must have a proper sense of proportion, particularly when talking about automation. The Institution had had its Conference and its meetings, and they were all enthusiastic—rightly. The future was in the hands of the production engineer. But had they not over-sold automation? Had they not to spend the next 12 months explaining it? They had overdone it. It was not the £100,000 machines which mattered. That was not the goose which would lay the golden eggs which would feed us in the future. Some people seemed to imagine that Britain was the only country with this goose. They were trying to eat the eggs before they had been laid. The Americans and no doubt the Russians had automation, too. The Japanese were good copyists and they would soon have it.

In some sections of the Press, pictures were seen of factory gates with hundreds of men going in and out and notices, " Hands Wanted "; and other pictures showing automation, a huge metal man, with a little fellow alongside, and notices, " No Hands Wanted ". That was rubbish—and there had been more rubbish talked about automation than about anything else in recent months.

The production engineer's future was interesting and the prospects exciting. It had been a wonderful past but the opportunities for the future were far greater.

Reverting to the toast, Sir Leonard said that when he saw the list of guests which the energetic Secretary intended to invite, he wondered how he had the temerity to ask them! As for the eminent gentlemen who had accepted, it was a great compliment to the Institution and they were all welcome. It would be invidious to mention names for there were as many guests—or almost—as members.

One of the two principal guests was Sir Brian Robertson, Chairman of the British Transport Commission.

The other guest of honour was Mr. A. B. Waring, Chairman and Managing Director of Joseph Lucas Limited.

It was pleasant to see both those gentlemen present and he asked everyone to drink to their health.

Sir Brian Robertson, responding, said:

" I see that you had a General as your principal guest last year. It is becoming quite a habit. Sir Ronald Weeks was the first man to be appointed to run the Military Government of Germany under Lord Montgomery in 1945. It was due to his temporary indisposition that it became my lot to be sent there. Subsequently Sir Cecil Weir, your President of 1952-53, became my principal adviser there in the economic field. He is now, I am glad to say, a Member of the Transport Commission. When he mentioned tonight's occasion to me, I needed no persuasion to accept your generous invitation.

" It might seem at first that the transport industry, meaning by that the provision and operation of public transport services, is a little beyond the recognised arena of the production engineer. However, remember in the first place that the Transport Commission is quite considerably involved itself in manufacture and repair. Nearly 80,000 men are employed in our railway locomotive and carriage and wagon building and repair shops and depots alone. As is well known, British Railways do far more themselves in this direction than any other railway system. This is a state of affairs which springs from history and I am well aware that some people dislike it, but I can't discuss its merits or demerits at this time. I do claim, however, that the importance of the work of the production engineer is very fully recognised in our shops, and I think that most people who

The presentation of Institution awards was a happy occasion. Here General Lord *(left, standing)* receives a Georgian silver teapot from the President. Seated are Lord Sempill, Past President, and Sir Brian Robertson.

visit them are well impressed by their efficiency in spite of the fact that many of the buildings have had their centenary celebration. Engineers still boast of being Crewe-trained, or Swindon-trained, just to mention two of our largest shops.

The Transport Services

" To turn to our transport services themselves, whether or not you regard this as being strictly within the purview of the industrial engineer, I should like to record my opinion that substantially increased productive efficiency is a matter of survival to the industry. I shall be centering my remarks mainly on the railways but, in passing, I might point out that public transport by road, whether passenger or freight, is confronted by ever-increasing competition. The public omnibus has been virtually driven off the streets in many cities of America and the country omnibus or coach is rapidly disappearing from many of the roads on the European continent. As privately-owned transport increases, public transport finds it more difficult to live.

" To get back to the railways, however, the most immediate problem which confronts us at this moment is shortage of staff in certain key areas. I am sure that our difficulties in this respect are not generally realised but they are serious. Our customers very naturally complain if trains are late or freight is delayed, but they little realise how much last minute improvisation has often been necessary to get their train through at all. We are cancelling freight trains every day of the week for lack of shunters, guards, firemen, etc. The shortage extends to many grades, not only those normally regarded as skilled, and the situation is not likely to get much easier for us while our full employment lasts. Now there are industries which, when they are short of staff, can restrict their output accordingly, but we must keep our service going at all times, and we are already finding this extremely difficult.

" We are doing our best to recruit more men, but you will not need me to tell you that we are handicapped in the auction for labour as against many forms of private enterprise. We shall not, however, in my opinion, solve our main problem by any form of recruiting stimulant and the truth is, that we have got to obtain bigger and more effective results in proportion to the manpower we employ.

Eliminating the Nonsenses

" There are three ways in which this can be done. The first is to eliminate what I may perhaps call the nonsenses. Although much of the talk about redundancy and restrictive practices in British Railways is very ill informed—' cocktail bar criticism ' to borrow a phrase from the " Daily Telegraph " today —it would be strange indeed if such a long established and conservative industry had a blameless record in this respect. What industry has? You may at least like to know that the matter is being tackled—in conjunction with the Unions of course, but Trade Union co-operation is not likely to be forthcoming in this field unless it is clear that at the end of the road management is determined to manage. A good deal more has been done already than is generally realised. The numbers employed have fallen from 641,000 in 1948 to 571,000 at this time. Even when allowance has been made for unfilled vacancies, this represents a big effective saving.

" The second way to increase productivity is to improve the processes, and by processes I include both the equipment and the way in which it is used. We must re-tool the railways. We must make one signalbox with modern devices do the work previously done by about six, one marshalling yard do the work of four, one diesel locomotive haul as many trains as previously entailed two or three engines in steam. (These figures are not accurate, but near enough for my purpose.) We must mechanise our goods terminals and our traffic and commercial accounting. We aim to introduce electronic machines for the recording, sorting and tracing of freight wagons; this may prove to be the biggest single contribution to greater economy and efficiency in railway freight operations. Equally important, we must recast our operating methods until every man-hour, and every engine mile, produces sufficiently more to relieve us of our labour troubles, to ease our present serious financial preoccupations and above all to furnish a very greatly enhanced service to the country. If you will allow that these things properly fall within the realm of the production engineer, then you will see that the scope for that gentleman on British Railways is a wide one.

Attitude of Mind

" But efficiency in industry is not purely a technical question; it is also an attitude of mind. It is for this reason that we are taking so much trouble at this time through our Productivity Council and other means to explain the situation and to preach the gospel of the production engineer. So often the resistance to new methods which would lead to increased production is based on misunderstanding and fear. I said a short while ago that increased productivity was a matter of survival for British Railways; once that is fully realised, all difficulties will of course disappear. An industry which employs as many men as do British Railways, and has difficulty in filling its vacancies, is bound to take in some people of all sorts, but fortunately there is a solid core of very fine men who give devoted service to the railways and are waiting to be told how they can do yet better.

" I was very interested to read the accounts of the Conference which you held at Margate last June. Automation is a horrifying word and I am never quite sure what it means. One thing automation certainly does not mean is that our wants will be supplied without anyone doing any work. Our Maker never intended that kind of a world and He will not permit it. We need not expect that in the forseeable future our trains will drive themselves and operate their own points and signals, while some Big Brother buried in the bowels of Euston Station controls the whole railway system with a lift of his

eyebrow. If, however, automation means increasing to a high degree mechanical devices whereby the effective result of human endeavour is greatly multiplied, then automation is on its way to British Railways.

" Mark you, I am not prophesying that at the end of the road British Railways will necessarily be employing appreciably smaller numbers than they do today. If management and man really combine to push this three-point programme through with all their might, and if they are backed up by the Government, the railways will so increase their traffics that they may need as big a staff as now and incidentally they will be in a position to face their wage bill with equanimity, nor will the country grudge the money.

" The necessity for craftsmen will certainly remain and increase.

" I am very well aware that when people hear me talk about what is going to happen on British Railways in the future, they are apt to react with the thought: ' this may be very well but what is being done to make things better right now? ' I have not of course time, and this is no place, to deal with that question, but that does not mean that I ignore its importance.

" I hope that I have not bored you too much talking about the activities of the Transport Commission. I make it my excuse that while you engineers aim to streamline and cheapen the processes of production, your factories are still dependent upon reliable and speedy transport at economic rates. I should like to congratulate the Institution on all they are doing to secure this greater productivity and to assure you that we in nationalised transport will do our utmost to keep in step. Moreover, we will draw upon the experience and data which you can make available.

" On behalf of all your guests, I extend our best wishes to your Institution. We hope that your Exhibition and Conference next year at Olympia will be a great success and we thank you for asking us to be with you tonight."

Mr. A. B. Waring, also responding, said he was particularly honoured to be asked to join in expressing the thanks of the guests, for he was not a production engineer and was not even an engineer; he was nothing more than an overhead charge, and no form of technological change could alter that unfortunate fact! (*Laughter*).

The production engineer had very considerable responsibilities. He was responsible for the expansion of the export trade, for increased production, for the maintenance of full employment, for improving the standard of living and for closing the dollar gap. In addition, he was no doubt also responsible for keeping Mr. Littlewood and Mr. Vernon happy (*Laughter*). He was a veritable Atlas with his load of responsibilities.

He could also claim another achievement; as an outcome of his efforts, he established pride in work. Skilled and unskilled workpeople took pride in their place of employment when its equipment was of the best and its methods of production were modern. Pride was one of the two vitamins of industrial life; the other was loyalty. Loyalty was related to the past and pride to the present. Those two things were essential for the health of industry.

Mr. Waring illustrated this with a war-time experience, when a small Lancashire mill was emptied of all its old equipment and turned into a modern factory with the best machinery and methods of production. It soon became the great ambition of all the workers there to do better than the parent factory in Birmingham.

Everything went extremely well until the war was nearing its end, when the mill was visited by a Government official, who told the workpeople that there was no future for them in the type of work they had been doing during the war and that they must be prepared to return to the cotton industry.

The Lancashire workers, who comprised the factory's Joint Production Committee, were always very outspoken and, after the Government official's visit, they sent for Mr. Waring and told him they were going to strike. They explained that it was nothing to do with him and there was nothing he could do about it. Upon interrogation, they made it clear that they were going to strike because they did not want to return to the cotton industry, and that was the only way in which they could demonstrate their purpose.

The point was that before the war they had had loyalty to cotton but, having left the industry and entered the engineering industry, the break had destroyed their old loyalty. They took pride in the work they were doing and could not believe that there was any prospect of working with pride in a cotton mill with its out-of-date equipment and facilities.

He added his praise to all that had been said of the work of the production engineers. The guests all realised the heavy responsibilities which production engineers carried. He joined Sir Brian Robertson in thanking the Institution, on behalf of all the guests, for the invitation to attend the dinner and for the most generous hospitality.

Presentation of Institution Awards

The PRESIDENT, in presenting the Viscount Nuffield award, said it was appropriate that he should do so because he was certainly the best prize Lord Nuffield ever won! (*Laughter*). It was appropriate that the prize should go to his namesake.

The following were the awards:

The Viscount Nuffield Paper, 1954. A presentation of a Georgian silver teapot was made to Major-General W. A. Lord, G.B., C.B.E., for his Paper entitled, " The Corps of Royal Electrical and Mechanical Engineers and the Application of Modern Management and Production Technique ".

The George Bray Memorial Lecture, 1954. A presentation of a silver cigarette-box was made to Mr. Robert Douglas, M.B.E., for his Paper entitled, " Engineering and Production Aspects of Synthetic Fibre Manufacture ".

Mr. Guy Cubitt-Smith *(left)* receives his award.

The Institution Medal for the best Paper presented by a Member during the year 1953-54, was presented to Mr. K. J. Hume, for his Paper entitled, " Fundamentals of Gauge Design ".

The Institution Medal for the best Paper presented by a non-Member during the year 1953-54, was presented to Mr. F. Nixon, for his Paper entitled, " The Effective Utilisation of Material ".

The Hutchinson Memorial Award, for the best Paper presented by a Graduate during the year 1953-54, to Mr. G. Cubitt-Smith, for his Paper entitled, " Resistance Welding in America ".

REPORT OF THE MEETING OF COUNCIL

Thursday, 27th October, 1955.

THE second Council Meeting of the 1955/56 Session was held at 10 Chesterfield Street, London, W.1., on Thursday, 27th October, 1955. The meeting, at which the Chairman of Council, Mr. G. R. Pryor, presided, was attended by 23 members, and the following were present by invtation:—

Mr. T. A. Horsley, Honorary Secretary of the Tees-side Section, and Mr. F. T. Dyer, Chairman of the Eastern Counties Region.

Election of Vice-President and President-Elect

It was recommended by the Finance and General Purposes Committee, and unanimously agreed, that Mr. E. W. Hancock, M.B.E., should be invited to become Vice-President and President-Elect of the Institution.

Finance

The Chairman reported that the Accounts for the year ended 30th June, 1955, would be circulated by post to all members of Council. This would enable queries to be raised before the Accounts were presented to the Annual General Meeting in January.

It was reported that Mr. H. Burke, immediate Past Chairman of Council, and Mr. A. F. Kelley, had been co-opted to the Finance and General Purposes Committee.

" Broadening of the Base "

The Chairman reported briefly on the findings of a conference on this subject held at Head Office. The matters discussed were firstly, the Institution's own examination syllabus, and the possibility of exemptions for men who came to production engineering later in life, having obtained their technical qualifications in other fields; secondly, educational facilities with regard to membership outside the United Kingdom and, thirdly, the question of practical training and its interpretation, both in the U.K. and abroad. It was fortunate that Mr. H. G. Goyns, President of the South African Council, was able to attend and give the meeting a first-hand account of the problems confronting the Sections outside the United Kingdom.

The recommendations of the Conference were being studied by the Education and Membership Committees.

Co-operation with PERA

It was reported by the Chairman that a very productive meeting had taken place between representatives of PERA and representatives of the Institution. He was able to report, firstly, that lectures on technical subjects were available for inclusion in Section lecture programmes and, secondly, that PERA had invited the Council of the Institution to hold one meeting annually at Melton Mowbray. It was agreed that this should take the form of an Open Day for the Institution as a whole.

The most important point arising out of the meeting was that PERA had offered to accept two or three junior members on an Institution sponsor-

ship basis for the six months' courses organised at PERA. It was agreed that this offer be accepted in principle, and that the Education Committee be asked to explore the proposal in detail.

Conference of European University Professors

The Secretary reported that this Conference, which is planned to take place at Delft, Holland, might prove to be extremely valuable. The Conference was designed to enable a small delegation from the Institution, under the leadership of Sir Walter Puckey, to have discussions with Professors of European Universities where production engineering has been taught for many years. There was a possibility of obtaining a dollar grant rowards the cost of the Conference.

Conference on Fine Measurement in Industry

The Secretary also reported that he had attended, on behalf of the Institution, a Conference on Fine Measurement in Industry held recently in Paris. Several Institution members had also been able to attend. The Conference included a number of extremely interesting works visits.

The Secretary had presented the President of the Conference, on behalf of the Institution, with a copy of the Report of the Margate Conference.

The Journal

It was reported by the Editorial Committee that a new series of leading articles had been arranged to commence in November, on the subject of " Designing for Production ". The first contribution was by the President of the Institution, Sir Leonard Lord, K.B.E., on the motor-car industry. A further series of leading articles on automation was being considered for publication early next year.

After careful consideration, and in response to many requests from members, the Committee had decided to discontinue the use of wrappers for despatching the Journal, in favour of envelopes. The change would take place early next year.

Summer School, 1956

The Education Committee proposed that the next Summer School should be held at Ashorne Hill at the end of July or August, 1956, and that the theme should be connected with the new industrial age (including automation, the automatic factory, or control engineering) and liberal studies.

Production Exhibition and Conference, 1956

It was reported that arrangements for the Production Exhibition and Conference, to be held from 16th May to 31st May, 1956, in the Grand Hall, Olympia, were proceeding satisfactorily. The theme of the Conference was to be " Investing in Success ", and the Advisory Committee was at present busy preparing the programme.

Membership

The Membership Committee had recommended that the size of membership certificate should be more in accordance with the normal standard for professional qualifications. Future certificates would be issued in the size approximately 7 in. by 9 in., in a design similar to that at present in use.

A considerable number of engineering firms were now approaching the Institution for recognition of their Apprenticeship Training Schemes, in order to fulfil the practical training requirement for membership. Provided the schemes were satisfactory, firms were being informed that those candidates who had completed their scheme would be deemed to have fulfilled the practical training requirement.

Institution Papers

The following report was made by the Papers Committee:

1955 *Sir Alfred Herbert Paper.* This would be presented by Dr. N. H. Mackworth, Head of the Applied Psychology Research Unit of the Medical Research Council at Cambridge, at the Royal Institution, London, on Thursday, 9th February, 1956.

1955 *Viscount Nuffield Paper.* As already reported, this Paper would be presented by Dr. G. H. Daniel, Chief Statistician of the Ministry of Fuel and Power, at the Royal Institution, London, on 15th December, 1955.

1955 *George Bray Memorial Lecture.* Sir Gordon Russell, Director of the Council of Industrial Design, had agreed to give a Paper in February or March next year. The meeting would take place in London.

1956 *Sir Alfred Herbert Paper.* Dr. B. V. Bowden, Principal of the Manchester College of Technology, had accepted the Institution's invitation to present this Paper.

1956 *Viscount Nuffield Paper.* Dr. Grey Walter, of the Burden Neurological Institute, Bristol, had accepted the Institution's invitation to present this Paper.

Research

The following reports were made on behalf of the Sub-Committees of the Research Committee:

Materials Handling. It was reported that a Syllabus and Examination Working Group had been formed.

Material Utilisation. Although the Report on Material Utilisation had now been published, the Sub-Committee had been asked to remain in being and submit its views on future work which could be done in this field.

Production Control. The final Report of the Sub-Committee was now being printed.

Sources of Information. It was reported that the Sub-Committee was continuing its work and was now engaged on the preparation of the detailed entries for the proposed Directory, which it was expected would have a useful life of about five years before major revision would be required.

With the publication of the Production Control Report, the work of the Joint Committee with the Institute of Cost and Works Accountants came to an end. The Research Committee felt, however, that some form of Joint Committee should be kept in being, and the terms of reference and future policy of such a Joint Committee were being discussed with the I.C.W.A.

Standards

The Standards Committee recommended that there should be established a Joint Standing Committee with the British Standards Institution, which would be responsible for arranging future conferences of Standards Engineers.

It was also reported that the Standards Committee had asked all Graduate Sections to consider the desirability of including at least one lecture or discussion evening on standardisation during the coming session. The response so far had been very favourable.

With regard to automation, the Committee felt that there was a real need for some standardisation of basic dimensions for transfer untis and transfer machinery, and proposed to go into this matter in some detail.

Hazleton Memorial Library

It was reported by the Library Committee that the scope of the Library was now being increased to include books on automatic control and industrial electronics. The Committee had taken this action in view of the great interest aroused by the Margate Conference and the numerous enquiries received.

Liaison with Sections outside the U.K.

The Vice-Chairman of Council, Mr. H. G. Gregory, reported that among the visitors the Institution had been pleased to welcome to Head Office during the summer were Mr. le Cheminant, Mr. Sutton, Mr. Strick and Mr. Worthington, from Australia; Mr. Stedman, Mr. Burden and Mr. Goodchild, from India, and Mr. Hyams from South Africa. In addition, Mr. H. J. G. Goyns, President of the South African Council, had visited Head Office recently, and had attended part of the conference on " Broadening the Base ", where he had made a valuable contribution to the discussion.

A visit was shortly expected from Mr. E. J. W. Herbert, Vice-Chairman of the Melbourne Section.

Discussions were going on with the Canadian, New Zealand and Sydney Sections regarding membership qualifications, examination requirements, and other problems, which had also been discussed at the special conference.

Following the success of the " Productivity and the Machine Tool " Conference held in Sydney last July, the Sydney Section were considering the possibility of a residential conference for Institution members only, on the lines of those run in the United Kingdom.

Applications for Membership and Transfer

The Council approved a number of applications for membership and transfer, details of which appear on page 820/821 of this Journal.

Local Section Reports

The Council received a number of Local Section Reports, extracts from which appear on pages 821 of this Journal.

Formation of Melbourne Graduate Section

The Council approved the recommendation of the Finance and General Purposes Committee that a Melbourne Graduate Section be formed.

Honours

The Council learned with pleasure that Her Majesty the Queen had conferred the following awards on members of the Institution:—

O.B.E. ... R. A. Wright, Member.
M.B.E. ... E. Ayland, Associate Member;
W. G. Bennett, Member;
J. W. Gardner, Associate Member.

Obituary

The Council recorded with deep regret the deaths of the following members:—

Sir Charles Bartlett, Member
W. R. Baynard, Member
H. E. Bower, Member
L. Ellam, Affiliate Representative
H. J. Hudson, Member
F. Hughson, Member
I. R. Owen Ellis, Associate Member
W. L. Proud, Associate Member
L. C. Saam, Associate Member
Sir John Storey, Member
R. Taylor, Member
T. Thornycroft, Member.

Date and Place of Next Meeting

It was agreed that the next meeting of Council should be held at 10 Chesterfield Street, London, W.1., on Thursday, 26th January, 1956, and that the Annual General Meeting should take place at two o'clock on the same day.

AUTOMATION - THE INSTITUTION'S POLICY

Following the general business of the Council, a discussion took place on the Institution's future policy in regard to automation. Each member of Council had received, prior to the meeting, an analysis of the Press comment on the Institution's Margate Conference and on the introduction of automation generally. (This analysis is reproduced on pages 817/819 of this Journal.)

The discussion was opened with the following written statement from Mr. M. Seaman, Chairman of the Editorial Committee, and one of the speakers at the Margate Conference:—

" 1. A tremendous impact was made in the Margate Conference and recent Institution Journals on the Institution's association with this subject. This should be powerfully exploited in editorial, technical and educational policy.

" 2. The present phase of over-popularisation of automation will have a national reaction in ' debunking '. These swings should be compensated by accurate statistical and technical studies of the impact of automation in the United Kingdom, Europe and the world at large, promoted strongly by the Institution of Production Engineers, and constantly published through its Journal and publications channels.

" 3. An expert advisory board on papers and publications should be built up in association with the Institution, largely based on Institution members, and attracting the best authorities in other fields. This board could aid the Papers and Editorial Committees in the development of world level, high quality Papers and policy statements.

" 4. Our natural association with Trade Union bodies and International Planning Authorities in Europe and America should be used for the development of the professional angle of publication through the Institution on the wide platform which it provides, and using the broadening of the base policy so as to treat all major industries on a national basis. Designing for production studies and material conservation studies are already in hand, through the Institution's Editorial and Papers Committee, which could be naturally allied to this attack.

" 5. A research sub-committee on automation should be formulated to channel the contacts with the highest scientific and commercial levels of activity, and the promotion of curricula on special studies in the Universities and Higher Technical Colleges should be an essential part of policy and tied to the development of at least 50 Departments with Chairs of Production Engineering in the Universities of the United Kingdom and Commonwealth, and the doubling of fully qualified Associate Member level, of the membership of the Institution over the next ten years, inspired and stimulated by the effective prospects of automation developments in all industries of the U.K. and Commonwealth.

" 6. A discussion on policy of the Council should be formulated in a paper to be jointly prepared by the Editorial, Papers and Research Committees of the Institution, and this should devise a statement of planning and policy which would be worked by the Institution in the forthcoming years in a consistent manner ".

In response to the Chairman's invitation to open the discussion, Sir Walter Puckey, immediate Past President of the Institution, said:—

" I suppose it can be said that I as much as anyone else am responsible for the Margate Conference, in which case it is only right that I should bear the brunt. But I believe I am bearing the brunt continuously. Please do not misunderstand me. Other people are doing it too, but I have had a very hard life since Margate and deserve it, because I helped to bring it about.

Tremendous Interest

" I have had no less than 57 invitations since I came back from Margate, and I have addressed meetings all round this country, and abroad, on automation. For some reason quite unknown to me, I am now regarded as an expert. You know what an expert is—an ordinary chap away from home, and naturally I always accept invitations to meetings in the provinces, never in London. I have had to turn down a large number, because automation is not the only thing I live, breathe and eat. Nevertheless, it is a symptom of the tremendous interest, not only in this country but abroad. A week hence I am off to Holland for three days to lead a seminar of leading Dutch businessmen on automation, and there I shall be very much an expert, because I shall be a long way from home!

" Some of our colleagues—Mr. Frank Woollard, for example—are having much the same experience, and are addressing meetings in various other countries.

" This gives you an indication of what has happened since Margate. If one thing is necessary in this country, it is that more members of this Institution —which is situated right in the core of automation— should be able and willing to talk to groups of men around the country on the true aspects of automation.

" First, in sheer self-defence and second, because I believe in sharing the load, I have put a number of applicants on to my colleagues in this Institution. Several of them have taken up this load and, like me, have decided to find out what it is before talking to others about it. We are having some difficulty as we go along, but we are learning. We are learning by *force majeure*, because we have to look convincing

when we get up in front of a group of people. This is a salutary exercise. But we senior members should encourage ourselves and our colleagues to talk about automation with knowledge, sense and conviction.

" Automation has seized the imagination of many sorts of people. I have had requests from political parties on both sides, from associations, technical colleges, universities, private groups of people, business men getting together over dinner at night. I have had a request to provide speakers for a range of lectures at colleges, and institutions such as Hatfield Technical College and Coventry Technical College are organising series of lectures on the subject.

Significance of Automation

" The interest is widespread, and this is an indication of the wide interest in the Institution and, for instance, the dilemma of PERA, which has decided that it must, at the moment, because the field is wide, tackle transfer machines only through its new committee on automation.

" Before we say any more about the Institution's responsibilities, it might not be a bad idea to give you my own thinking on the significance of automation to production engineering and business generally.

" I have read a lot about it in recent months, and the more I read the more I realise that here is a possibility which will have a very much wider impact upon all sorts of happenings in business, commerce and elsewhere than almost any other technique. It provides, in an over-simplified definition, an expansion of man's brainpower, his controlling power, to help him use machine power more effectively.

" You and I realise that for many years we have been concerned with mechanisation. It has been in our blood, and we have built up an industry, many industries, on the basis of more and more power to many elbows, more and more muscle amplified by machine power. We are still a long way behind the Americans—only one-third as far along the road; and therefore we realise that mechanisation is not only something on which we have built our lives and livelihoods, but something that must continue.

Many Possibilities

" Automation, with its many inherent possibilities, will give greater opportunities for the brain, in a variety of ways, to be amplified along much the same lines as you and I have magnified brawn and muscles for many years past.

" I could talk a lot about electronic brains and current researches into the human brain, but let it suffice to say that, even from my layman's viewpoint, I regard the brain as capable of magnification which in turn will give greater magnification to the men and machines it controls.

" This may sound very profound indeed, and because brainpower is universal, its expansion will not only affect mechanisation as we apply it to the *productive* industries in this country. It will apply everywhere, to all those industries and occupations where brainpower and control power are used and can be used more effectively. I have, for my own convenience, divided the area of application into three main groups. If we take this country alone, we have 24 million people alleged to be gainfully employed. Of that 24 million, roughly eight million are working in factories, not all on machines or so-called benches, but nevertheless, broadly speaking, on the factory floor somewhere or another. You and I concentrate largely upon multiplying their brawn by machines and better systems.

" What about the other 16 million? Of that 16 million, probably four or five million work in offices in the ordinary accepted commercial sense of the word. There are nearly three million clerks still pushing pens and papers around. There are also many millions (and they will grow as our standard of living increases) of people in what I call service occupations. When you book for the Continent, ask the R.A.C. for a route, buy a ticket for an aeroplane, put money in the bank, or do a thousand and one other things that are regarded as part of the amenities of life, someone performs a service. The more our standard of living grows, the more will that group of people grow. By and large, they do their jobs less efficiently than in the industrial section of the community. You have only to line up in a variety of queues to realise how much better these jobs could be done.

Improving Customer Service

" There are many ways in which these services could be improved to the benefit of the customer. Let me give you a couple of simple examples. Until recently I could go into many American banks and get passed from one section to another until I received my money. Today, in a flash all the necessary information, my photograph and other details, can be televiewed from one department to another, and I stay where I am. And in a fraction of the previous time, I, as a customer, get more satisfaction.

" Many of you have shared the experience of going to a New York railroad station and waiting for a Pullman booking. You may remember the days when you lined up in front of a booth and waited while a clerk enquired about space. The first step towards helping him was to provide his telephone with a rubber block to free both hands. Today you, the customer, can be helped because the booking is done in a fraction of the time. All the information is on a magnetic drum and automation has come to help both clerk and customer.

"These are simple examples of customer service and some may say: ' Is the production engineer interested in that sort of application? We have a big enough job among the eight million people, as PERA have on transfer machines alone '. That may be true, but what other body is so well equipped, with not only the knowledge to bring machines to our help, but also using men and women efficiently in the process? I do not believe there is any other single body which has the experience, inclination and possibilities that you and I have as production engineers.

" Therefore, as automation is, as I believe, an expanding activity, I would suggest that we are better able than the majority to understand and interpret it to those other 16 million people, most of whom at the present time, in my experience, have not the faintest idea what it is all about. That is a task we might well consider it worth our while to do.

A Clear Understanding

" How can we do it?. First, we ought to understand more clearly the definition and implications of automation and how it might help to bring about a more fruitful future. To be able to talk about it, you must study it. I have spent a lot of time trying to understand automation in its widest sense. I have tried to understand what I have just told you and greater understanding has reinforced my determination to help in spreading that knowledge. Tremendous repercussions could follow if automation were not understood and put over properly.

" You have in front of you a summary of press comment on the public's reaction to automation. You can see that it is a many-sided problem. Labour looks at it one way, sociologists in another, technicians in another, and so on. You know as well as I do that today one of our biggest problems is to put over a development like this constructively, and thank goodness organised labour has so far been most constructive in its reactions to automation.

" I do not think that is accidental. It is because of discussions like the Margate Conference, where we have tried to be positive, to show that automation is not only a narrow technology, but something affecting all groups and all people. We tried to achieve a sense of balance.

" You and I can only meet the present situation effectively and satisfy the ever-growing wish of people to find out more about automation by understanding it more clearly ourselves, deciding that we will talk about it, and getting some of our promising colleagues to talk about it. We must build up a group of people in the Institution who can be relied upon, when requests are received, to talk intelligently and authoritatively on the subject.

" To my mind, that is the biggest single task this Institution has to do at the moment, Any further steps beyond that may well be discussed afterwards ".

A full and detailed discussion followed Sir Walter's address and it was finally decided to set up a special Committee to investigate the full implications of automation. This Committee, under the Chairmanship of Mr. A. F. Kelley, will study the implications of automation in the broadest sense, and will pay particular attention to the effect of automation on the human being and on human relations in industry and in society.

Other members of the Committee are Sir Leonard Lord, K.B.E., President of the Institution; Mr. G. R. Pryor, Chairman of Council; Mr. H. G. Gregory, Vice-Chairman of Council; Mr. E. W. Hancock, M.B.E., Director and General Manager, Humber, Ltd.; Sir Walter Puckey, immediate Past President of the Institution; Mr. B. H. Dyson, General Works Manager, Hoover, Ltd.; The Earl of Halsbury, Managing Director, National Research Development Corporation; Mr. M. Seaman, Director and General Manager, British Oxygen Engineering, Ltd.; Mr. R. Telford, General Works Manager, Marconi's Wireless Telegraph Co. Ltd.; Mr. F. G. Woollard, M.B.E., and Sir Francis Brake, Managing Director, Creed & Co. Ltd.

" THE AUTOMATIC FACTORY— WHAT DOES IT MEAN? "

A summary of Press Comment by Daniel Viklund, London Editor, " Dagens Nyheter ", Stockholm.

1. This report tries to answer the question: " What does the public think about automation?"

2. The answer is a summary of Press views and comments on automation and related problems before, during and after the Institution of Production Engineers' Conference in Margate, 16th to 19th June, 1955. General comment in the technical papers has been considered, but the main source has been the national and provincial Press.

3. Automation has provided Press headlines for some time. The Margate Conference, however, has very much stimulated discussion. Press coverage of the Conference was extensive. In terms of column space, that coverage concentrated heavily on some particular addresses at the Conference, mainly by Sir Walter Puckey, the Earl of Halsbury, and Mr. F. G. Woollard, and to a lesser extent, by Professor B. R. Williams and Mr. E. Fletcher. The subjects of these speakers give a clear indication of the focus of public interest.

4. The theme of the Margate Conference was

" The Automatic Factory—What Does It Mean?" Views and comments in the Press, as analysed and summarised in this report, cover a wider field. Present automation in a number of factories, in Great Britain and abroad, automation on a larger scale than is the case now, and conditions and problems of a future " completely automatised " society, probably together form the mental background on which public opinion in the matter is based.

5. Basically, automation—admittedly to an unspecified degree—is seen as unavoidable. The technical and scientific problems of automation are taken as solved, completely in theory, nearly completely in practice. Two reasons are given for the belief that automation will, and must, come in Britain.

6. The first reason can be summarised thus: While the dangers and risks of automation are obvious, they can, and must, be overcome. It is held that the potential gains from automation, held to imply an overall, unprecedented increase in the standard of living (in the widest sense) are such that it would be wrong—apart from being impossible—to retard developments.

7. The second reason is international competition. It is assumed that above all the United States, Russia and Germany, Britain's main industrial rivals, would in any case go ahead, with consequent disastrous effects on British competitive export capacity if this country should lag behind.

8. There is, also, very apparent in the popular Press, what might be called the romantic appeal of automation. Behind the way the subject is presented there is a hope that Britain may, by a combined progress in nuclear energy and automation, lead a " second industrial revolution " and appear as the leader, or at least secure her standing as a leading industrial power, in a new age. In this way, automation " catches on " sometimes, perhaps, at the expense of a number of realities.

9. With few exceptions, the Press features automation in two sharply contrasting ways. On the one side there is a new Garden of Eden, less work, more money, more leisure. On the other, mass unemployment, slavery of the industrial masses, and power of machine robots. But, on the whole, the former picture is given much more prominence than the latter, with dangers much less stressed than possibilities.

10. The question of how soon automation will become a full-scale reality is accepted as fundamental, but the answers to it are many. Uncertainty prevails on the problem to what extent and in what degree various industries are ripe, suitable or desirable as fields of automation. Excluding a number of oversimplified estimates, it seems fair to assume, however, that public opinion believes the real difficulties still to be fairly far ahead, and that the immediate problems concern a gradual transition to a new situation.

11. A demand for " more planning ", direct and specified on the political left, more vague but apparent in other quarters, is obvious in public thinking on the subject. It is, more or less clearly, said and written that a co-ordination, on a hitherto unknown scale, of governmental, industrial, social and scientific authority may be necessary in order to master—preferably in advance—the problems of an " automatic age ". The possibility of such a course leading to a higher degree of State control is not always appreciated.

12. The attitude of the industrial working class is seen as the main reason for success or failure of any advance degree of automation. Insofar as real resistance against automation is foreseen, or feared, fear of unemployment, and a subsequent stand for continued restrictive practices, are assumed to be the crucial factors. Responsible trade union comment, as reflected in the Press, appears not at present to stress this very heavily, mainly because it is believed that the transition will be gradual and that there still is a long time to adjust the working class attitude. It must—at least for the present—be assumed, however, that there would be real resistance against automation if the consequence appeared to be any direct disturbance of full employment.

13. Against this background, the necessity of a gradual redistribution between sectors of employment of the industrial working class stands out as a leading problem. Popular comment tends to assume, however, that automation will, in fact, cause no unemployment. (A number of emphatic assurances to that effect probably explain the comparative calm in which working-class opinion now judges the problem of automation). The assumption is that unskilled labour, if and when redundant in automatic factories, will be transferred to transport, services, distribution and marketing. It is also thought that a number of new industries will result.

14. On the political left there are fears—which may later become political arguments—that automation will be carried out by employers, not with the primary aim of increasing production and standards, but in order to reduce labour costs and increase profits. So far, moderate trade union leaders only maintain that automation will create no fundamentally new problems for a long time, and that trade union aims therefore will basically remain unchanged, *e.g.* directed towards improved working conditions and " fair shares ", simply on the basis of changes caused by gradual automation.

15. Automation is said unavoidably to demand improved and much more efficient industrial relations. As a very small number of men must be supposed to be able to stop vital production in automatic factories, industrial agreements of a new type—in fact, almost excluding strikes, are regarded as necessary. The

recent American agreements regarding guaranteed annual wages, etc., are quoted as examples of what should be done. There are also demands for a much more extended system of information to the workers regarding the new problems and implications of automation, preferably at an early stage.

16. The wider problem of technical, scientific and industrial education and training is generally regarded as of utmost importance in relation to automation. Some commentators foresee " a shortage of intellectual capacity " among the working-class when it comes to the need of a higher number of key-men in the factories. It is admitted, however, that the balance of skilled and unskilled labour in a society of advanced automation remains conjectural. There are some demands for a complete reorganisation of the whole school system to meet the new needs. The fact that there is, already now, a shortage of industrial skill on various levels is naturally an element in the discussion

17. Problems of management, industrial organisation, finance, capital equipment costs and related difficulties remain as a rule in an obscure background in the Press discussion on automation. The most positive answer as to how difficulties of that kind should be overcome is, generally, that the process will be gradual. There is also little consideration of the problems of prices, wages, and above all, selling of the augmented products of automation. Some papers state directly that automation cannot be carried out in a foreseeable future for the simple reason that neither labour nor capital will be available in a sufficient degree. It is an obvious consequence of public thinking of automation—taken in its widest sense—as it now stands, that difficulties are given less preference than possibilities.

18. If a conclusion is attempted, it appears to be that the man in the street, and the newspapers he reads, so far occupy themselves with the transitional problems of automation. The economic, political, sociological, technical and psychological effects of a completely—or at least to the fullest degree possible—" automatic society " remain, in fact, still in the realm of imagination. The bulk of comment in this field concentrates on such problems as leisure in a society with shortened working hours; it is easily understandable that public opinion on this point tends to concentrate its attention on the assumed blessing of automation only.

19. To this must be added the well-known fact—sharply illustrated by the general nature of Press comment and views on automation—that the newspapers have a tendency to dramatise the picture. They paint the bright sides and leave the shadows out, especially as the darker side is so much more difficult to appreciate and foresee. In spite of any evidence to the contrary, the public also probably believes—rightly or wrongly—that the real problems of an automatic age still lie comparatively far ahead. The result is a tendency—on the whole entirely natural—to avoid any interpretation in terms of direct effects upon the individual.

20. Above all, the present period of full employment creates no necessity for the working-class—or for any other section of society, except experts and specialists and the leaders of industry, for that matter—to face the issues. In spite of the degree to which automation has in certain instances been carried through, the automatic age remains a part of an uncertain future. Rank and file working-class reaction, probably most important from the mass opinion point of view—as it would be the first to feel direct effects of far-reaching changes—remains something of a latent and uncertain factor. Public opinion—as reflected by the Press (and this qualification in itself involves a limitation)—does at present look at a picture of automation in a fairly benevolent way. Once the issues in the field have to be more sharply defined, doubts and opposition might crystallise in a manner which cannot now be foreseen, still less judged in its consequences.

ELECTIONS TO MEMBERSHIP AND TRANSFERS APPROVED BY THE COUNCIL APPEAR OVERLEAF

ELECTIONS AND TRANSFERS

27th October, 1955.

BIRMINGHAM SECTION

AS MEMBER
C. E. Adie.
AS ASSOCIATE MEMBER
J. Morris.
AS ASSOCIATE
K. Pennycuick.
AS GRADUATES
F. W. Bolton, J. T. Clews, R. C. Evans, L. T. G. Graham, J. B. Hodges, C. F. Johnson, J. R. Johnston, W. J. Matthews, F. J. Rudd, W. A. Stephens, M. D. Yates.
AS STUDENTS
P. S. Eden, L. R. Kauffmann, D. J. Lloyd, G. B. Norval.
TRANSFERS
FROM ASSOCIATE MEMBERS TO MEMBERS
F. J. Bradbury, F. R. Humphrey.
FROM GRADUATES TO ASSOCIATE MEMBERS
G. H. Aston, F. W. Firkins, G. H. Gummery, R. J. Read, O. F. Rendell, J. F. Smith.
FROM STUDENT TO GRADUATE
D. R. Haywood.

BOMBAY SECTION

AS MEMBER
P. V. Shah.
AS ASSOCIATE MEMBER
R. J. R. Patell.
AS STUDENTS
R. Dayanidhi, P. K. Mukherjee.
TRANSFERS
FROM GRADUATES TO ASSOCIATE MEMBERS
A. U. Sheikh, D. Williams.
FROM STUDENT TO GRADUATE
M. T. Khan.

NEW AFFILIATED FIRM:	NEW AFFILIATED REPRESENTATIVES:
The Khatau Makanji Spg. & Wvg. Co. Ltd.	N. V. Ullal. B. G. S. Iyengar.

CALCUTTA SECTION

AS ASSOCIATE MEMBER
A. F. Eugene.
AS STUDENTS
B. S. Aulluck, S. P. Bhasin, P. R. Ganesh, D. K. Sinha.

CANADA SECTION

TRANSFER
FROM GRADUATE TO ASSOCIATE MEMBER
J. Killingback.

COVENTRY SECTION

AS MEMBER
W. C. Toll.
AS ASSOCIATE MEMBERS
L. J. Leavers, R. Norton.
AS ASSOCIATE
L. J. Hoefkens.
AS GRADUATES
D. W. Ashmore, J. S. Evans, G. E. Failes, P. J. Flynn, M. K. Mukherjee, S. Goss.
TRANSFERS
FROM GRADUATES TO ASSOCIATE MEMBERS
J. W. Burton, J. G. H. Pearce, C. Peters.
FROM STUDENT TO GRADUATE
S. L. Heys.

DERBY SECTION

AS ASSOCIATE MEMBER
H. W. Barlow.
AS STUDENT
J. H. Welch.
TRANSFERS
FROM GRADUATE TO ASSOCIATE MEMBER
E. R. Brealey.
FROM STUDENTS TO GRADUATES
R. Barr, N. Gadsby.

EDINBURGH SECTION

AS MEMBER
K. G. Legh-Winter.
TRANSFER
FROM ASSOCIATE MEMBER TO MEMBER
A. B. Brown.

GLASGOW SECTION

AS ASSOCIATE MEMBER
A. Hodge.
AS GRADUATES
W. T. Baird, V. K. Burley, T. E. Cole, M. P. Makhijani, T. Murray, B. K. Sen.
TRANSFERS
FROM GRADUATES TO ASSOCIATE MEMBERS
J. L. Gutteridge, J. M. Miller.

GLOUCESTER SECTION

AS GRADUATES
A. G. Hutcheon, E. R. Marshall.
AS STUDENT
P. H. Bingle.
TRANSFER
FROM STUDENT TO GRADUATE
B. E. G. Clarke.

HALIFAX SECTION

AS GRADUATES
D. J. Broxholme, E. Wilkinson.
AS STUDENT
S. K. Bhalla.
TRANSFERS
FROM GRADUATES TO ASSOCIATE MEMBERS
M. Ashworth, W. R. Gaudion, J. K. Greenhalgh, P. Iredale.

LEICESTER SECTION

AS ASSOCIATE
R. C. Mills.
AS GRADUATES
G. N. Essex, G. H. Starmer.
AS STUDENTS
J. Cooper, H. S. Guron, P. W. Jones, P. C. Lai, L. K. Rivo, J. T. Sullivan, M. J. Trinder, R. G. Willson.
TRANSFERS
FROM GRADUATE TO ASSOCIATE MEMBER
D. H. Seymour
FROM STUDENTS TO GRADUATES
J. W. Frakes, D. Laxon, D. G. J. Swinfield.

LINCOLN SECTION

AS ASSOCIATE MEMBER
A. W. Wentworth.
AS GRADUATES
I. C. E. Rodrigues, D. Russell, H. Thomasson, W. Vann.
AS STUDENT
T. M. Macadam.

LIVERPOOL SECTION

AS ASSOCIATE MEMBER
A. J. Scales.
AS GRADUATE
T. P. Callaghan.

LONDON SECTION

AS MEMBERS
R. W. Harris, J. A. Sargrove.
AS ASSOCIATE MEMBERS
C. A. Bate, H. Dyson, L. Goodman, F. O. Latimer, J. P. Raffe.
AS GRADUATES
I. Ahmad, B. J. Allen, J. A. Austen, P. Brown, J. H. Cope, J. E. Dooley, C. H. John, R. H. Leaney, A. W. Orchard, R. E. Puttick, I. R. Reid, L. S. Richman, H. R. Robinson, L. E. Rodwell, R. Sirkin, H. C. Smith, P. J. Thompson.
AS STUDENTS
H. E. G. Arter, P. D. Beedie, D. J. Fairbrass, C. A. Hills, A. R. Johnson, R. A. Judd.
TRANSFERS
FROM ASSOCIATE MEMBERS TO MEMBERS
J. M. Brice, G. A. J. Witton.
FROM GRADUATES TO ASSOCIATE MEMBERS
H. Barclay, P. T. Brown, D. Collier, W. H. Jackson, L. A. Liddle, H. Rawcliffe, S. J. Sterrett, H. R. Sumner, B. R. Westwell.
FROM STUDENTS TO GRADUATES
D. Buckland, R. E. Catterwell, D. F. Skelton, P. R. Smithers.

NEW AFFILIATED FIRM:	NEW AFFILIATED REPRESENTATIVES:
Siemens Bros. & Co. Ltd. ...	A. W. Newbold F. S. Morley

LUTON SECTION

AS ASSOCIATE MEMBER
F. R. Towner.
AS GRADUATE
D. F. E. Pidgeon.
AS STUDENTS
D. G. Griffiths, C. N. Johnson, J. A. Plumley, A. J. Porter.
TRANSFERS
FROM GRADUATES TO ASSOCIATE MEMBERS
T. Barker, F. G. Ethelston, H. Layton, T. W. Parry.
FROM STUDENT TO GRADUATE
G. F. Barclay.

MANCHESTER SECTION

AS MEMBERS
H. Gladney, H. A. Wallace.
AS ASSOCIATE MEMBERS
H. H. Harrison, A. Horn.
AS GRADUATES
M. Dewhurst, C. L. Pyman, M. O. Short.
AS STUDENTS
T. A. Bainbridge, S. A. Hatton, B. V. Redford, T Swift, R. Wright.
TRANSFERS
FROM ASSOCIATE MEMBER TO MEMBER
J. D. W. Taylor.
FROM GRADUATES TO ASSOCIATE MEMBERS
D. Eastwood, R. A. Mackay, J. P. Speakman.
FROM STUDENTS TO GRADUATES
S. Clare, T. Potts.

MELBOURNE SECTION

AS MEMBER
H. M. Cooper.
TRANSFERS
FROM ASSOCIATE MEMBER TO MEMBER
E. Rodeck.
FROM GRADUATES TO ASSOCIATE MEMBERS
H. J. Faull, J. Simon.

NEW AFFILIATED FIRM:	NEW AFFILIATED REPRESENTATIVES:
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NEW ZEALAND SECTION

TRANSFER
FROM GRADUATE TO ASSOCIATE MEMBER
D. J. I. Gray.

NORTH EASTERN SECTION

AS ASSOCIATE MEMBERS
J. E. Glasper, T. B. Tait.
TRANSFER
FROM STUDENT TO GRADUATE
T. J. Julier.

NORTHERN IRELAND SECTION

AS GRADUATE
D. C. Crowther.
AS STUDENT
W. I. Morrow.

NORWICH SECTION

AS STUDENT
D. J. Baxter.

OXFORD SECTION

AS GRADUATE
L. W. Frost.
AS STUDENT
G. E. Perkins.

PETERBOROUGH SECTION

TRANSFER
FROM STUDENT TO GRADUATE
R. Laxon.

PRESTON SECTION

AS MEMBER
G. H. Ayres.
AS ASSOCIATE MEMBER
J. Blundell.
AS GRADUATES
S. F. Forshaw, J. Harwood, L. F. W. Mutter.
AS STUDENTS
J. Barton, A. Baxter, K. Bibby, G. I. Bishop, A. S. Smith, B. Wright.
TRANSFERS
FROM GRADUATES TO ASSOCIATE MEMBERS
R. Cleary, G. H. Gamble, A. J. Vine.
FROM STUDENT TO GRADUATE
J. N. Whittaker.

READING SECTION

AS ASSOCIATE MEMBERS
G. J. Cockrane, C. J. Doyle.
AS GRADUATES
J. A. Murrell, R. P. Pike.
AS STUDENT
D. M. Sellwood.
TRANSFER
FROM ASSOCIATE MEMBER TO MEMBER
A. G. Jones.

ROCHESTER SECTION

AS MEMBER
B. A. Austin.
AS GRADUATES
J. R. Anderson, B. N. Cox.
TRANSFERS
FROM ASSOCIATE MEMBER TO MEMBER
H. Davenport.
FROM STUDENT TO GRADUATE
E. G. Tottman.

SHEFFIELD SECTION

AS MEMBER
C. Evans.
TRANSFER
FROM STUDENT TO GRADUATE
R. Foster.

SHREWSBURY SECTION

AS GRADUATE
K. Hall.
TRANSFER
FROM ASSOCIATE MEMBER TO MEMBER
H. J. W. Smith.

SOUTHERN SECTION

AS GRADUATE
A. L. Window.
AS STUDENTS
F. J. Coombs, R. G. Luther, A. G. Mills, D. G. Mills, E. G. Moody, J. N. Stevens, R. E. Toms, A. C. Wiseman.
TRANSFER
FROM ASSOCIATE MEMBER TO MEMBER
R. H. H. Kingdon.

SOUTH ESSEX SECTION

AS MEMBER
S. J. Gudgeon.
AS GRADUATE
R. C. Stubbs.
AS STUDENT
B. B. J. Smith.
TRANSFERS
FROM GRADUATES TO ASSOCIATE MEMBERS
A. E. Adcock, G. A. Blackshield, J. S. H. Budds, D. Marsland, R. A. Norton.

SOUTH WALES SECTION

AS GRADUATE
D. N. Thomas
TRANSFER
FROM GRADUATE TO ASSOCIATE MEMBER
A. E. Haynes.

STOKE SECTION

AS ASSOCIATE MEMBER
J. P. Leech.
TRANSFERS
FROM GRADUATE TO ASSOCIATE MEMBER
W. R. Bailey.
FROM STUDENT TO GRADUATE
R. M. Hunt.

SYDNEY SECTION

AS MEMBER
A. P. Stapleton.
AS GRADUATE
K. F. Whitton.
AS STUDENTS
J. C. Campbell, D. A. Wilson.
TRANSFERS
FROM GRADUATE TO ASSOCIATE MEMBER
A. W. G. Cox.
FROM STUDENT TO GRADUATE
N. O. Turner.

WESTERN SECTION

AS MEMBER
J. H. Larrard.
AS ASSOCIATE MEMBERS
E. J. V. Beagley, A. J. McMaster, C. K. Muller.
AS GRADUATE
D. H. Smellie.
AS STUDENTS
T. L. Hawkes, D. G. Williams.
TRANSFERS
FROM ASSOCIATE MEMBERS TO MEMBERS
J. Bottomley, R. W. Hancock, W. J. Lane, W. E. Wright.
FROM GRADUATE TO ASSOCIATE MEMBER
S. H. Day.
FROM STUDENTS TO GRADUATES
K. G. Lane, T. G. Mossman.

WEST WALES SECTION

AS GRADUATE
G. C. Fear.
AS STUDENT
K. Wylie.
TRANSFERS
FROM ASSOCIATE MEMBER TO MEMBER
W. J. T. Dimmock.
FROM STUDENT TO GRADUATE
D. F. Perry.

WOLVERHAMPTON SECTION

AS MEMBER
J. S. Lancaster.
AS ASSOCIATE MEMBER
C. G. Smith
AS GRADUATES
L. J. Cox, E. R. Millard, T. W. Pagett.
AS STUDENTS
J. E. Burton, S Harper, J. H. Latham, J. Marsh.
TRANSFERS
FROM ASSOCIATE MEMBERS TO MEMBERS
A. G. Pate, H. W. White.
FROM STUDENTS TO GRADUATES
T. J. Harrison, L. Jackson, J. K. Robinson, J. H Washbrook.

YORKSHIRE SECTION

AS MEMBER
T. D. H. Baber.
AS ASSOCIATE MEMBER
L. Magee.
AS ASSOCIATE
R. N. Hoard.
AS GRADUATES
A. Birch, E. Good, P. Rock.
AS STUDENT
R. O. Windley.
TRANSFERS
FROM ASSOCIATE MEMBER TO MEMBER
C. L. Sykes.
FROM GRADUATES TO ASSOCIATE MEMBERS
F. H. Moore, L. Swift, J. D. Wharton.
FROM STUDENT TO GRADUATE
J. Millett.

NO SECTION

AS MEMBERS
H. V. Barker, H. H. Plews.
AS GRADUATE
I. E. Doubleday.
AS STUDENT
D. W. Scargill.
TRANSFERS
FROM ASSOCIATE MEMBERS TO MEMBERS
A. R. Cason, R. W. McCreath, A. G. Pettit.

EXTRACTS FROM LOCAL SECTION REPORTS

Presented to Council, 21st July, 1955

EAST AND WEST RIDINGS REGION

Doncaster

The Section continues to grow at a steady rate and the lecture programmes appear to be now accepted as a regular item in the diaries of local engineers. There is now a considerable amount of co-operation between the Section and the Local Productivity Committee which is helping to make the activities of the Institution more widely known.

Production Engineering courses at Doncaster Technical College now appear to be bearing fruit, evidenced by an increased number of applications, and enquiries from younger prospective members.

An interesting lecture programme has been arranged for the new session and considerable interest is being shown in the first meeting, a lecture by Dr. Harrison, Chief Metallurgist, Sheepbridge Stokes.

Halifax

The winter programme opened on October 3rd with a Regional Lecture Meeting organised by the Yorkshire Section, and several Halifax members were present.

Apart from routine work which has been carried out in the usual way, there has been little incoming business during the summer months, but the Committee have the progress of the Section very much in mind, and several items will be discussed at the next meeting.

Halifax Graduate

A very successful Weekend School was held at Ilkley on Saturday and Sunday, 9th and 10th September, 1955. The opening speeches and discussion on the test-case attained a high level, and the Committee were honoured by the presence at the School of the Chairman of the Council, Mr. G. R. Pryor. The theme adopted for the School was " Management ".

A Graduate Paper Evening has been incorporated into the lecture programme for the coming session. The Chairman of the Graduate Section intends to approach the Senior Section to enquire whether the papers submitted could be judged by a panel of Senior Section members and a suitable prize awarded for the best paper.

The Chairman of the Graduate Section reported at a recent meeting on his visit to the last Council Meeting. He said he had felt very honoured to be asked to attend and that the experience had greatly benefited him.

EASTERN REGION

Eastern Counties

The visit to Manganese Bronne & Brass Co. Ltd., Ipswich, was made as planned. This is a most interesting works where several processes were seen in operation, which cannot be seen at other local firms.

The winter programme of lecture meetings has now been completely planned by the Section Committee, and several applications for membership have been discussed, but otherwise there has been little activity in the Section during the summer months.

Norwich

During the quarter under review, the Section Committee have met regularly, the main business being the 1955-56 programme, which was designed to appeal to all local engineers.

The Committee were sorry to lose, at the end of July, the valued services of Mr. F. H. S. Heidenstam, who had been their very efficient and conscientious Secretary for the past few years. Mr. Heidenstam left the district to take up a new appointment at Letchworth, and the Section wishes him well in his new undertaking.

Applications for membership and transfer have been discussed and recommendations made. The policy of " Broadening the Base " is always in the minds of the Committee members, who are eager to see the Section grow.

MIDLAND REGION

Birmingham

Summer activities were mainly of a social nature, the summer outing being held in July, when a pleasant afternoon and evening was spent at the Chateux Impney, Droitwich Spa, which culminated with an informal Dinner and Dance. This was well attended by 106 members and their ladies, and Mr. and Mrs. R. N. Marland acted as host and hostess.

Also in July members visited the Shell-Mex and B.P. Oil Refinery at Stanlow, Cheshire. Members had a most instructive tour of the refinery conducted by the technical staff, and were shown some of the large range of by-products produced. The trip was arranged by Mr. V. G. Haden, one of the Section members, and Mr. B. H. Leask.

At the June Exhibition and Conference on Industrial Safety at Bingley Hall, arranged by the Birmingham and District Group, Mr. J. Silver, a member of the Birmingham Section Committee, gave an address on " Safety from a Production Engineer's Point of View ". The Exhibition was well attended and the papers well received, with lively discussions following.

Birmingham Graduate

After a lull in activities due to the summer period, the Section got off to a good start in September with a well attended lecture on " Punched Cards in Production Control ", by Mr. E. S. Carden. The social event for September, a Car Rally, was quite successful, and full credit is due to Mr. P. Cashmore, the Social Secretary. Visits for the coming session cover a wide range of industries, from card box making to a sterilising dairy.

Coventry

The 1955/56 session got away to a very good start when approximately 100 members and visitors attended the lecture " Broaches and Broaching Technique " by Mr. A. A. Randle. " Ship Building ", the subject of the December lecture, is far removed from Coventry, but was particularly chosen in an effort to introduce wider variety into lectures.

Reference has already been made in the Journal to the departure from Coventry of Mr. H. D. S. Burgess. However, it is the unanimous wish of the Committee that a debt of gratitude should be recorded for the many years of hard work which Mr. Burgess undertook for the Coventry Section .

Shrewsbury

The new Committee has met twice since July, and among matters discussed were the finalising of arrangements for the Section Third Annual Dinner Dance to be held in Shrewsbury on Friday, 25th November. The Committee welcomed the announcement that the Shrewsbury Technical College were starting a course for the Higher National Certificate in Production Engineering, and feel that this will give suitable impetus to an influx of junior members and promote the formation of a Graduate Section.

The Programme Sub-Committee will be meeting at the beginning of October to start arrangements for the 1956/57 Session programmes.

The first lecture of the session, " The Industrial Gas Turbine ", was delivered to the Section at Shrewsbury Technical College by Mr. J. R. Needham, A.M.I.MECH.E., and the audience had an enjoyable and instructive evening.

Worcester

The activities of the Worcester Section during the July/September quarter have been restricted to Committee meetings, when the chair has been taken by Mr. H. C. Branfield, in the absence of the Chairman.

The programme of lectures for the coming session has been finalised and a scheme for the benefit of Students and Graduates of the Worcester Section has been discussed. It is tentatively proposed to arrange during the winter session 1955/56 two Saturday morning visits and Papers at two of the major firms in the area and restricting the number of Students and Graduates to 30.

Wolverhampton

The programme for the forthcoming session has been completed, and the Committee look forward to a most interesting series of lectures. The first Paper, by Mr. R. A. Rogers, on " Plant Maintenance and Productivity ", will be given at Wolverhampton on 19th October.

Since the subject of automation is so full of interest, arrangements have been made to include three Papers on this subject. Mr. J. B. Jay will present " Increased Automation of Existing Production Lines " at Stafford Technical College on 2nd November, and Mr. C. D. Camwell will give a Paper entitled " Unit Head Production " at Wolverhampton Technical College on 16th November. The latter Paper will be accompanied by a Renault Company film on automation.

The December Regional Meeting on 14th December at Wolverhampton completes the series of automation lectures with " The Implication of Automation ", by Mr. F. G. Woollard, M.B.E.

Interest has been aroused in an addition to the curriculum at Stafford Technical College whereby a course leading to a Higher National Certificate in Production Engineering has been introduced.

Wolverhampton Graduate

During July and August the Section do not arrange any lectures, due to the holiday period. A visit was arranged for 13th July to Joseph Sankey & Sons, Ltd., Hadley Castle Works, Wellington, which was well attended and proved to be of interest. Departments visited included the press shops, where presses ranging from 100 to 2,000 tons were seen in operation. The production of car bodies aroused great interest, and also the mechanical handling techniques. Other departments visited were the wheel shops and the Ferguson tractor department.

The first lecture of the session was held in September, when a very interesting Paper was given by Mr. J. Fallows, on " Process

Development of Shell Moulding ". This was supported by a very good colour film and slides. A lively discussion took place after the lecture and attendance was very good.

In addition to these activities the Committee have held two meetings per month, and the lecture and visits programme for 1955/56 has been completed. A Dinner-Dance has been arranged as a joint function with the Senior Section, and will take place at the Mount Hotel, Tettenhall, Wolverhampton, on Friday, 23rd December.

NORTH MIDLANDS REGION

Leicester

The Committee have dealt with a large number of applications for membership and are pleased to note that the majority have been successful. During the last quarter, Mr. J. France, who is head of the Department of Industrial Engineering at the Loughborough College of Technology, was co-opted to the Committee.

Arrangements are complete for what promises to be a very successful Annual Dinner, at which the chief guest will be Major-General K. C. Appleyard. It is hoped that all members of the North Midlands Regional Committee will be present, and also members of the recently formed Loughborough Student Section.

A letter from Mr. G. R. Pryor to the Section Committee regarding the construction of quarterly reports was well received, and it was pleasing to note that a direct link between Council and Sections could again be effected by this medium.

Lincoln

Since the last quarterly report, members have visited the works of B.T.H., Chesterfield, and Appleby-Frodingham, Ltd., Scunthorpe. The Section is very grateful to the Directors and Managers of these companies for allowing members to visit their works.

Arrangements have been made for the Lincoln Section to hold their Third Annual Dinner Dance which, it is hoped, will be up to the standard of the previous functions.

Nottingham

The excellent weather during the summer has tempted members to travel far and wide and extend their holiday period longer than usual. This has reduced the tempo of activities but the Section has, nevertheless, made two interesting visits, one to Chilwell Workshop of the R.E.M.E., and the other to the Engineering Department of Boots Pure Drug Co. Ltd., Beeston, where there were facilities for inspecting the mechanical handling equipment. On both occasions, the Section was extremely well entertained and everyone had a most enjoyable time.

The Section has had the misfortune to lose its Vice-Chairman, Major M. Fleming, M.B.E., R.E.M.E. Major Fleming has been posted to Aldershot, and the members of this Section wish him every success in his new duties. Mr. A. E. Stevens, Director of Raleigh Industries, Ltd., Nottingham, has agreed to deputise for Major Fleming until the next Annual General Meeting.

Peterborough

The 1955/56 programme of activities started with a visit to the Northampton Brewery Co. Ltd., in September. The remainder of the programme consists of another works visit, seven lecture meetings, and the Annual General Meeting. The lecture meetings include a joint meeting with the Peterborough and District Section of the Institute of Cost and Works Accountants, another with the Peterborough Branch of the Institution of Incorporated Plant Engineers. This follows a pattern set during the past few years, and will continue the very happy relationships which exist between the local Sections of both these organisations and ourselves.

NORTHERN REGION

North-Eastern

The meeting for the 1955/56 session have now been arranged, particular attention having been given to obtaining Papers by speakers with local connections.

The new session opened with the Chairman's address by Mr. F. Baker, and was very well attended. Mr. Baker's remarks were extremely interesting, and he illustrated some unique tooling methods.

Owing to the commitments of Mr. W. D. Opher taking him to another area, it is with regret that the Section records the loss of his services from the Committee, but have no doubt that his interest in the Institution will be continued.

North-Eastern Graduate

The lecture programme was finalised by early October and comprises five meetings, the Annual General Meeting, and three works visits. Three of the lectures are to be followed up by works visits, in order to give a greater appreciation of the Paper.

The Committee are proud of the efforts of Mr. R. W. Pickard, GRAD.I.PROD.E., who was successful in being awarded one of this year's Schofield Travel Scholarships. It is one of the first Scholarships to come to the North-East and it is felt that it may encourage greater participation by the members of the North-Eastern Graduate Section in entering for the next Scholarships.

The date of the first meeting is 7th October in Roadway House, Oxford Street, Newcastle, and in view of the recent redecoration of the Conference Room, and the two films to be shown on this evening, it is expected that the attendance will be well above average. Furthermore, by including on the posters distributed to advertise the lectures, a brief synopsis of the Papers, the Committee feel that they may encourage greater attendances.

Tees-side

The Tees-side Section has now completed the first year of its activities as a Section. The inaugural meeting was addressed by Sir Walter Puckey in September, 1954.

The Section covers a wide and scattered area, and on that account it was suggested and agreed that meetings should be held in both Middlesborough and Darlington. A fifty-fifty basis is now established practice.

The Section would like to record its appreciation for the help received from the Principal of the Darlington Technical College, Mr. Benyon, for allowing the use of the Lecture Hall and for assistance readily given in many ways.

At the Annual General Meeting in March, the Chairman and Secretary were re-elected, and a Vice-Chairman, Mr. J. W. Woodger, was elected. A programme consisting of six Papers has been arranged for the coming Session. In September, a Paper on " Modern Production Methods by Copying Process " was read by Mr. J. Lang, B.A. (CANTAB.), A.M.I.MECH.E.

NORTH-WESTERN REGION

Liverpool Graduate

Mr. A. J. Vine has resigned as Chairman of the Section, upon accepting an appointment in the South of England. Mr. Vine has done a considerable amount of work for the Institution in Liverpool. Mr. A. French also resigned from the Committee upon joining H.M. Forces. Mr. D. R. Portman has accepted the invitation to fill the vacancy of Chairman, and Mr. T. Parr has been co-opted to the Committee.

The first lecture meeting of the session took place in September, when Mr. D. R. Portman gave an excellent lecture on " Automation and Argon Shielded Welding ".

The Committee held a special meeting in September to discuss the Graduates' Conference to be held in Liverpool next April. Mr. Caselton, Deputy Secretary to the Institution, and Mr. Winskill and Mr. Pate of the Senior Section were also present. It was decided to broaden the Conference, to lay less emphasis on administrative affairs and to concentrate more on a junior conference for junior members of the Institution.

Manchester

The first lecture meeting of the session, held in September, was a Paper given by Dr. H. E. Priston, PH.D., B.SC., F.R.I.C., entitled " Modern Lubrication Technique ". This was well illustrated by slides and was followed by a lengthy and interesting discussion.

Mr. G. R. Parker, who has served as Honorary Secretary to the Manchester Section and also to the North-Western Region, has now left the Section to take up an appointment in the South

of England. Mr. J. P. Speakman, who is a past Graduate Chairman, has now taken over these duties. Among the officers for the coming year, the Section is fortunate in welcoming Mr. T. A. Stoddart as the new Section Chairman.

A " Ladies Evening " is to be held in October. It is hoped that this private effort by the Committee members will compensate the ladies for the evenings when their husbands have attended Institution meetings.

Manchester Graduate

Due to the election of Mr. J. P. Speakman to the Secretaryship of the Senior Section, various changes have taken place within the Committee. Mr. S. W. Whittington is now Chairman; Mr. R. A. Jones is now Visits Secretary; Mr. K. A. Pollitt is now Registrar, and Mr. F. Renwick is now Minutes Secretary.

The Committee is of the opinion that this delegation of duties to the various members will keep the Committee active and the members will have the feeling of taking part in the meeting rather than being bystanders. This system is not new to the Manchester Section, and the results can be judged by the fact that attendance at Committee meetings is very high.

Already this session there have been one lecture meeting and one visit. The lecture, on " The Gas Turbine Locomotive ", presented by Mr. P. F. Stock, B.SC., was well attended and a lively discussion ensued. The visit took place in the same week, when Section members joined with members of the Liverpool Graduate Section in a visit to Josiah Wedgwood, in Stoke.

The programme of lectures for the coming session is now being supplemented by works visits, which have been arranged to take place at approximately six-week intervals.

Preston

The arrangements for the winter session of lectures have now been completed. There are six lectures arranged by the Preston Section and one joint Regional lecture.

Close co-operation with the Productivity Committees in Blackburn and Burnley is being maintained and two of the lectures have been arranged in collaboration with these Committees. The first lecture will be " Productivity in Good Times and Ill ", and the lecturer, Mr. Lewis Wright, Secretary of the Amalgamated Weavers' Association. The second lecture will be held in January in Burnley, when the Section is to be honoured by a visit from Sir Walter Puckey, who will lecture on " Who is Responsible for Industrial Prosperity?"

An innovation this session will be the holding of one lecture at the Accrington College of Further Education, at the invitation of the Head of the College, Mr. S. R. B. Swann. Facilities will be given on that evening for the inspection of the workrooms, classrooms and laboratories of the College, which is one of the best-equipped in the North of England for the teaching of Production Engineering.

Stoke-on-Trent

Two Committee meetings were held during the quarter, both of which were extremely well attended. The syllabus for 1955/56 was finalised at the July meeting. It was agreed at this meeting that closer co-ordination with the local press would enlist their help in publicising lectures and activities and it was arranged that all lecturers should be asked to send a press release of about one hundred words, biographical details and if possible a photograph for publication.

Several changes in the Section Committee have taken place during the quarter. Mr. E. Perry has now taken over as Honorary Secretary from Mr. R. Rowley. Appreciation of the work carried out by Mr. Rowley was expressed at the September Committee Meeting, and members were pleased to hear that he would continue to serve on the Committee. Mr. A. G. Hayek, a member of the Institution's Research Committee, has been co-opted to the Section Committee.

It was with very great regret that the Committee accepted the resignation of Mr. J. W. East, due to a new appointment which necessitated him leaving the district. His services and advice had been greatly appreciated, and he takes with him the very best wishes of the Section Committee and members.

SCOTTISH REGION

Dundee

The Section Committee has been in active co-operation with the Local Productivity Committee, and all the lecture meetings arranged for the 1955/56 session have been declared open meetings, and included in the Calendar of Meetings on Productivity.

The first lecture of the season, " The Practical Application of Production Engineering Research ", was given by Dr. D. F. Galloway, Director of Research, PERA. This lecture was attended by many of the staff of member firms, and the information imparted led to a better appreciation of the facilities and methods of research and was bound to encourage requests for help and co-operation in the future.

A member of the Section Committee would like to put on record the great help he received from the Hazleton Memorial Library staff at this first request for information. The amount of data, the indexing, and the quickness of the reply, truly amazed him.

Edinburgh

The Section was inactive during the summer months, although much work has been going on " behind the scenes " in preparation for the new session . In a Section with a small and somewhat scattered membership, it is always a problem to arrange a lecture programme having the kind of interest that will ensure a consistent reponse and attendance from members throughout the session.

However, following the successful practice of previous years, this year's programme again, with one exception, puts the accent on local interest. The exception was the opening meeting, held in September under the new Chairman, Mr. A. Betts Brown. The programme consisted of two films, each dealing with an entirely different aspect of production engineering. The first film, " Planned for the Purpose ", was made by the British Electrical Development Association and, despite the inevitable bias towards matters electrical, did represent a sincere attempt to demonstrate the advantages of production planning. Case studies covering the three types of production—mass, batch and unit—were dealt with to show how improvements could be effected.

The second film, " Tumbling into the Future ", was made by Messrs. Cruickshanks of Birmingham, and dealt with barrel polishing. The use of colour aided this film considerably as it traced the history and development of barrel polishing from the earliest times up to the present day. It was clear from the film that research and development, which is still going on, will considerably widen the already wide scope of this useful process.

SOUTHERN REGION

Oxford

Following the retirement of Mr. L. P. Coombes, Mr. J. W. G. Pringle has been elected Section Chairman for 1955/56. Mr. M. J. Inston has found it necessary to resign from the Honorary Secretaryship of the Section, after holding that office since its inauguration, and it is hoped that a keen member of the Section will offer his services as Honorary Secretary.

For the new session of lectures, the theme of " Automation " has been adopted and a big programme of lectures bearing on his subject has been arranged. Included in this are Papers to be read at Witney, Bambury, and Bicester, so that more members in the outlying areas of the Section may have the opportunity to attend. A joint meeting with the I.C.W.A. has also been arranged and will take place in January.

The first meeting of the session to be held in Oxford will take place in October, when Mr. F. Griffiths and Mr. H. N. Holbeche, of the British Motor Corporation, will speak on " Automatic Transfer Machines ". Local members of the Institutions of Mechanical and Electrical Engineers have been invited to this meeting.

Reading

A most interesting visit was made by 30 members and friends in June to the works of C.A.V. Ltd., Acton. This visit proved to be one of the best arranged by the Section, and is highly recommended. A feature noted was the high proportion of individual skill developed by C.A.V. Ltd.

A Regional Social Visit for members and their ladies—was made this month to the Southampton Docks. This was arranged by the Southern Section, and a party of 45 greatly enjoyed the occasion.

SOUTH-EASTERN REGION

London

Arrangements for a full lecture programme are nearly completed, and include speakers on the following subjects: Steel Supply Problems; CO_2 As A Coolant; Comparison Between Broaching and Milling; A Symposium of Unusual Toolmaking Methods.

Further lectures are being arranged to complete the programme for the coming session, with the usual two lectures in the Croydon area and one at Brighton.

The Committee would welcome information from the Council with regard to the progress of "Broadening the Base". The Committee would also appreciate any information available with regard to the possible alteration of membership qualifications, in particular, in relation to examination requirements. If any changes are contemplated, the Committee feel that an early statement on the subject would considerably assist young engineers in pursuing an appropriate course of study.

Luton

The Section commenced the current lecture programme in September with a very successful lecture on "Mechanical Handling", given by Mr. F. T. Dean, M.I.MECH.E., M.I.PROD.E., at the works of W. H. Allen Sons & Co. Ltd., Bedford. A very satisfactory attendance was recorded.

At the time of writing it is not known what the response will be to a Productivity Exhibition, arranged by the Luton and District Prlductivity Committee, in October. Liaison is being maintained between the Section and local neighbouring Productivity Committee.

Luton Graduate

The first lecture of the new session, "Jig Boring Machinery" by Mr. W. H. Jaye, was a great success. It was, in fact, difficult to close the meeting, such was the interest aroused among the audience. Graduates made up sixty per cent. of those present and the total attendance equalled the best at any meeting last year. The new Committee find this an encouraging sign that their drive to increase Graduate participation in Section activities is meeting with success.

Following up the final lecture of last session, a visit was made to Messrs. Wharton & Wolcocks, of Hertford, where points made during the lecture were demonstrated.

South Essex

The programme for the 1955/56 session has been successfully arranged, and several well-known speakers have agreed to give Papers to the Section.

As in previous years, the Committee have tried to include subjects with a wide range of interests and the meetings will be held alternately at Chelmsford and Ilford.

SOUTH-WESTERN REGION

Cornwall

Very little activity has taken place in the Section during the summer months. The winter lecture programme arrangements have been delayed by structural alterations at the Technical College Lecture Hall, where the Institution holds most of its meetings. The hall is now much larger, and has greatly improved accommodation. The first meeting there is being arranged for next month.

The Committee met several times during the summer to discuss the Compressed Air Conference, and in view of the success met with last April, it has been decided to proceed with arrangements for a similar venture at Easter, 1957.

Gloucester

The programme is now settled for the coming winter. There are some joint meetings with other societies with similar interests, such as the Gloucestershire Engineering Society, which was founded in 1881 and has had a lively life through the years, in mechanical, electrical and civil engineering; it makes considerable grants each year for prizes to the technical schools in the district.

The applications for membership are increasing; the time taken in Committee on the applications is quite considerable, as care is being taken to ensure that the standard is kept at a high level.

Western Graduate

The lecture programme for the current session has been finalised. From past experience, subjects concerning recent developments in production techniques have been chosen, as their appeal to the young engineer is far greater. Mr. Broadbridge is dealing with "Ultrasonic Machining" in October, and Mr. Radcliffe will cover the field of "High Speed Machining".

The Section organised a very successful works visit to the College of Technology, Bristol, in July.

The Committee have given consideration to arrangements adopted by Head Office regarding the transfer of members from one Section to another, and the information concerning these supplied to the respective Sections. A large number of members of the Section leave the area to join H.M. Forces. As they are technically still in the same Section, the Committee have no knowledge of the exact number of members still active in their area, on whose support they always rely. It is therefore recommended that information regarding National Service, etc., be sent to the Section Secretary.

WELSH REGION

S. Wales and Monmouthshire

Although this has been a "close season" as far as the lecture programme is concerned, the Committee have been extremely active in preparing for the winter session. Efforts to stimulate interest in the activities of the Institution, with special emphasis in the Graduate Section, have been made by the Chairman. A personal letter has been sent to each member of the Section, inviting suggestions for a lecture programme, or other innovations which would stimulate interest.

At the first lecture of the session, on "Extrusion of Metals", the attendance was 130. This is an excellent start to the session and it is hoped that this response will be maintained.

Interest in the Institution in the area is increasing, and it is pleasing to note that Higher National Courses in Production Engineering have been introduced at the Colleges of Further Education at Merthy and Aberdare.

SECTIONS OUTSIDE THE U.K.

Adelaide

At the June meeting, Mr. A. Johnson, A.S.T.C., A.M.I.E.AUST., gave a Paper on "Radio Valve Production". In July, 30 members visited the Aircraft Division of Chrysler Australia, Ltd., and were shown over the plant, which produces numerous assemblies for jet bombers and pilotless aircraft. In September, members and visitors heard a lecture on "Standard Costing" by Mr. A. L. Betheras, B.COM., A.A.S.A.

Three Committee meetings have been held during the quarter. Further progress has been made towards setting up a course in Production Engineering in Adelaide. The syllabus is being arranged between the education authorities and the Education Sub-Committee.

Melbourne

The Section is very happy to report a most active and successful quarter. The meeting in July took the form of a question night on metallurgical problems. A panel of experienced members from the Australian Metals Institute capably answered questions put to them by production engineers. In August, 139 members and visitors attended a meeting to hear a paper on the "Cavitron New Die Sinking Process", from Mr. John Mair, which was very enthusiastically received.

The culmination of much work over the last twelve months was the proposal of the formation of a Melbourne Graduate Section. This was formally resolved at a special meeting of Graduates in August. The Melbourne Section Chairman, Mr. C. Pullen, and four Committee members attended this meeting The Section Secretary, Mr. R. Deutsher, was instructed to place the results of this meeting before the Council and propose that a Graduate Section be established in Melbourne.

A record number of 170 members and friends attended the meeting in September to hear a Paper on "Some Problems Encountered in Producing the Avon/Sabre Jet Fighter", by Sir Lawrence Wackett, D.F.C., A.F.C., B.S.C., F.R.A.S., who has pioneered the design and production of aircraft in Australia.

Sydney

The Section Papers for this year cover a very wide variety of subjects, and the June Paper, on " Industrial Plastics ", was presented by Mr. G. L. Brunskill, B.SC. Particular reference was made to the part played by plastics in the chemical industry.

Twenty members visited the Australian Iron and Steel Limited works in June. Several million pounds have been spent in the last few years on new rolling mill equipment, and members saw the latest equipment in use.

A Committee meeting was held in July, and a Production Engineering Conference was held in conjunction with the first Machine Tool Exhibition to be held in Sydney; automation was the main theme. Mr. W. P. Eastwood, M.I.PROD.E., a Halifax Section member, spoke at the Conference, and addressed the August meeting on " Copy Machining in the General Machine Shop ". Aided by some very interesting films, Mr. Eastwood delivered a most instructive lecture.

In September, Mr. G. C. Heyde presented a Paper on " Work Study of Non-Productive Departments ". The lecture was well received, and judging by the questions asked by members, the subject is one of ever-increasing interest to cost-conscious production engineers.

New Zealand

No Committee meeting was held in June, but instead, the evening was devoted to a lecture on the work of salvage, by the Royal Navy, of the wreckage of the Comet jet airliner, " Yoke Peter ", which crashed into the sea, south of Elba, in January, 1954. This lecture was given by a naval officer who participated in the work, and the engineering aspect of the undertaking was both interesting and instructive.

Committee meetings were held in July and August, and after the latter, a very interesting evening was spent viewing films, kindly loaned by Stewarts and Lloyds, Ltd., on the manufacture of steel tubes, and the construction of the Great Jib and " Pluto ".

Calcutta

In August a film show, accompanied by a talk on " Die Forging Hammers ", was arranged at the Lighthouse Miniature Cinema Hall in Calcutta. The air-conditioned accommodation proved to be so congenial and popular that it was decided to hold future meetings there. The August visit was to the works of Guest, Keen & Williams, Ltd., at Howrah, which proved to be very interesting, and was attended by 25 members. In September, a Paper entitled " Production Control " was presented by Mr. P. J. O'Leary, A.M.I.PROD.E., A.R.A.S., to a very well attended meeting.

Two Committee meetings were held in July and September. At the latter meeting, Mr. N. N. Sen Gupta was elected Honorary Treasurer.

South Africa

The meetings in July took the form of a Film Evening, when the following films were shown: " Principles of the Petrol Engine "; " Aircrew "; " Atomisation "; " Hydraulics "; " Transfer of Power ". In September, Mr. John Steels, a Past President of the Institute of British Foundrymen, gave a lecture on " The Lost Wax Process ". The Paper was very well attended and members of the Institute of British Foundrymen were invited to join in the proceedings. The lecture was supplemented by coloured illustrations and a brief demonstration.

The Annual General Meeting and Dinner of the Institution was held in August, and was very well attended. Amongst the many distinguished guests present were several of the leading personalities in the metal industries. The proceedings were enlivened by four excellent addresses which, besides being humourous, stimulated consideration of some of the many problems which face the production engineer in his daily operations.

The outgoing President, Mr. W. G. Gillespie, presented the report of the South African Council and at the conclusion thereof, members were unanimously of the opinion that although the year had been relatively quiet, nevertheless the South African branch had shown encouraging indications of its anticipated progress in future years.

South African Council and Committee Meetings

During the quarter under review, the South African Council met on three occasions, and the Membership and Papers Committee on three occasions.

4. arranging that the variety of finish coats can be baked at a consistent time and temperature so as to aid the mechanisation of dip, spray, electrostatic and baking operations to a conveyorised process.

The choice of finishes having good covering properties, such as the special " two-tone " or " hammer " finishes, can eliminate considerable ' elbow grease ' preparations. The ideal is, of course, not just skin-deep finishes, but self-finishes such as aluminium, stainless steel, plastic mouldings, thermo-plastics, rubbers, ceramics, etc.

Sub-assembly and main assembly operations were for many years known as " fitting and building " and to an embarrassing degree consisted of hand rectification of faulty and inaccurate machining. Large quantity flow line production demands high standards and consistent quality of the component parts. It is often the case that the production engineer requires the designer to dimension the component from a specific datum location and to limit the tolerances in order to ensure high and consistent quality.

The conveyor belt was first introduced in 1860 to convey food from the kitchen to the dining room, but its present main industrial application is concerned with the assembly line. Frequently conveyorised assembly is a myth of mechanisation, except for material handling, because invariably the majority of the actual assembly operations are " hand made ".

Designing for production can be very effectively applied to increasing assembly efficiency, right from the simple locating projection and offset locating hole which determines that a bi-metal contact strip is assembled the right way up on its mated part, to the design that obviates assembly by moulding or casting the components in position. The die casting of the heating element into position in an iron soleplate is a typical example of this. Where a variety of types of a basic product are required, good design will accommodate these variables so that they can be added as a final operation on the component, or be taken care of at the end of the assembly line.

In the present-day large-scale production of consumer goods to meet the highly competitive market, it is difficult and perhaps even wrong to attempt to draw a strict line of demarcation to indicate where the design function, the drawing office duties, and the production responsibilities begin and end. It is, in fact, vital that there should be a closely integrated and co-ordinated effort.

Perhaps the best advice to offer the designer is : " When in doubt rub it out ", because the eraser is much less costly to use than the cutting tool or the welding torch. Production engineers should nevertheless appreciate the very real problems connected with design, for possibly with no other function is it more true to say; ' It is so easy to make a thing complicated but very difficult to make it simple '. A company's finest ' hallmark ' is undoubtedly the good design of its products.

Finally, let us remember that in the end, design—particularly of consumer goods—is a compromise. It embodies the best thinking of the many individuals who contribute to it. The foremost engineering executives are those who know when there has been sufficient development and discussion and when action shall take place. It is of little value to produce the world's most perfect consumer goods only to discover that the market has progressed to other fields.

London Graduate Weekend School

The Sixth Annual Weekend School organised by the London Graduate Section was held once again at the Beatrice Webb House, Dorking, on 14th-16th October, 1955. Thirty-eight members, visitors and guests attended the School, which this year took the theme of " Inspection for Production ". This subject attracted several visitors who were able to take part in and contribute to the discussion after each lecture.

The social aspect of the event was not neglected, and on the Friday evening 14 visitors and members enjoyed a pleasant evening together.

The programme of four lectures was designed to cover as many aspects of inspection as possible in the short time available, and this the lecturers did without undue overlapping of subject matter. The lectures were as follows:—

Saturday, 2 *p.m.* " Accurate Measurement as an Aid to Scientific Production Engineering " by L. Hare, G.I.MECH.E.

Mr. Hare explained the reasons for having accurate measurement, together with the methods of obtaining it. By the help of charts and slides he showed that accurate measurement allows more scope to the setter in the machine shop, by showing him where there is a deviation from a nominal size, and not only that the component is correct within a certain tolerance. During the discussion the uses of air gauging equipment were elaborated upon.

Saturday, 7.30 *p.m.* " Automatic Inspection " by J. A. Sargrove, M.I.E.E., M.BRIT.I.R.E.

By using case history films, Mr. Sargrove showed how in automatic production, the inspection function must be a part of the process, and that if errors occurred the machine had to compensate for the errors, stop the production, or reject the faulty component. During the extensive discussion, it became obvious that both production and inspection engineers would have to revise their thoughts, before automation became a full-time part of the country's production.

Sunday, 10 *a.m.* " Some Problems in the Aircraft Industry " by M. G. W. Bloeme.

In this lecture, the audience were brought back to the realms of day-to-day problems, most of which are to be met in the majority of works. Mr. de Bloeme showed how, in a batch production shop, the use of quality control, in which the information obtained is charted and shown to the operators, will give rise to better control of machine setting, and a competitive spirit among the operators.

During the discussion several problems were put to the lecturer, which he was able to solve adequately.

Sunday, 2 *p.m.* " Organisation and Administration of the Inspection Department " by A. S. Owers, M.I.E.I.

Mr. Owers explained the responsibilities of the Inspection Department, the organisation of both large and small works, and the duties of the various levels of inspection staff. He propounded that the design and checking of gauges, and the Standards Room, should be the responsibility of the Production Engineer, the products from the tools and gauges being the responsibility of the inspector.

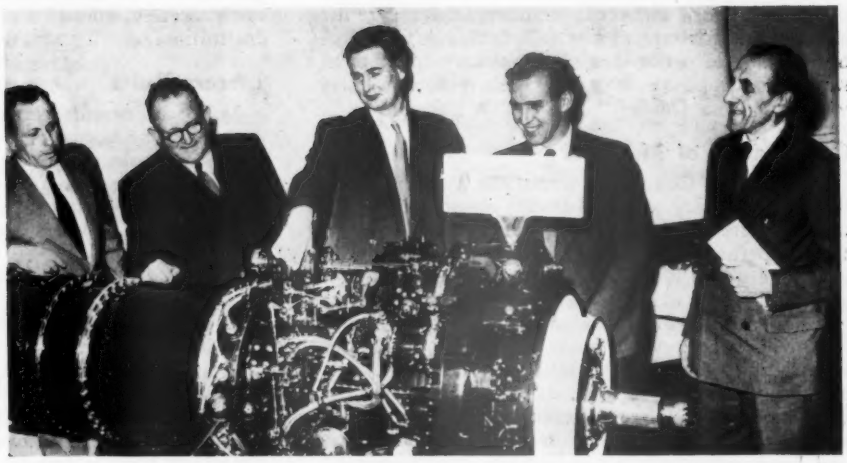
The discussion showed that there are many different views on the organisation of the department, but that this may be due to the varying sizes of works.

Mr. R. E. Leakey, London Senior Section Chairman, as Chairman of the School, summed up the various aspects of the lectures presented.

A vote of thanks was expressed by Mr. G. Jeffs, of the Inspection Department of B.O.E. Ltd., on behalf of the visitors, whom he felt had enjoyed a most instructive and pleasant weekend with the Graduates. This was followed by a vote of thanks by Mr. R. T. Mustard, Graduate, for the fine effort put into the organising of the Weekend School by the Committee.

The proceedings terminated at 4 p.m.

The Sheffield Section held their Annual Dinner at the Grand Hotel, Sheffield on 10th October, 1955. This group of guests obviously enjoying the occasion includes (left to right, front) Mr. H. F. Spencer; Mr. E. Levesley, Sheffield Section Chairman; Mr. F. A. Hurst, President, Sheffield Chamber of Commerce; Alderman J. Curtis, Lord Mayor of Sheffield; Mr. R. P. Phillips, Master Cutler. Back row, left to right: Mr. G. R. Pryor, Chairman of Council; Mr. W. F. S. Woodford, Institution Secretary; Mr. A. Robert Jenkins; Major-General K. C. Appleyard, C.B.E., Past President; and Mr. F. J. Everest, Halifax Section Chairman.



This photograph was taken at a recent meeting of the Southern Section in Southampton, when Mr. C. E. Wurr, of Armstrong Siddeley Motors, Ltd., spoke on "Basic Principles and Production Problems of Gas Turbines". (Mr. Wurr's Paper appeared in the November issue of the Journal). In the group, left to right, are Mr. C. Sumner; Mr. F. T. West, M.B.E., Section Chairman; Mr. Wurr; Mr. G. T. Hudson and Mr. H. C. Smith.

THE HAZLETON MEMORIAL LIBRARY

THE Hazleton Memorial Library was opened in 1950 as a memorial to Richard Hazleton, first General Secretary of the Institution, who died in 1943.

There must be many members who have not visited the London Headquarters, and who therefore have not seen the new library premises. The beautifully proportioned room with its blue and white ceiling and mahogany furniture is a fitting setting for a memorial to a great man. But buildings do not make a library: it is the books and the use to which they are put which are the memorial to Richard Hazleton. Since it was opened in October, 1950, the library has grown to 4,000 volumes, and has become one of the many excellent technical libraries in the country. It is the foremost production engineering library available to private persons and is used both by students and by practising production engineers. This has been achieved in the short space of five years. Only those who have helped to create libraries can justly appreciate this achievement and give due credit to the imagination and foresight of past and present members of the Library Committee, and to the hard work of the first Librarian.

Now, five years after its inauguration, the Library issues its first printed catalogue. The Committee has felt for a long time that there are many members who do not know of the facilities afforded by the library, and who are, indeed, unaware of the many sources of information available to production engineers. It thought that a printed catalogue would be the best means of bringing the Library to the attention of members, and that it would be very useful to these who are unable to visit it. It hopes that the Library will be an additional "tool" in the hands of production engineers.

It must, however, be remembered that a printed catalogue indicates, but cannot completely represent, the resources of a library. No libraries today try to cover fully every subject about which they might be asked. The system of inter-library loans in which almost every type of library throughout the country takes part is an economical and satisfactory way of supplementing a library's own stock, and there are therefore many subjects which members, when they examine the catalogue, may think are inadequately represented in ours. Moreover much of the up-to-date information on technical processes is contained

in periodicals to which several published indexes exist. No library information service such as ours could do its work without these indexes, which are the key to a great storehouse of information. Technical libraries while performing their primary function of supplying books, also cater for their numerous users who, like Rosa Dartle, " only ask for information ".

Co-operation of Members

The Library Committee would like more members to use the Library, and will always consider criticisms and suggestions; for good libraries are the result of the co-operation of all their users, and no library is a good one unless it is used. We think our Library is good and would like it to be better. The Committee is most grateful for the co-operation of the many volunteers who review books for the Journal and who help to compile the bibliographies which are published from time to time. It is greatly encouraged by the interest of younger members of the Institution, who provide a large proportion of the Library's users, and have served on its Committee. The Liverpool Graduate Section has formed a sub-committee to organise the reviewing of books within its area, and the Library's Book-Selection Sub-Committee has, until recently, consisted entirely of Graduates of the Institution.

Library Rules

May we remind members of the principal rules governing the borrowing of books from the Library?

1. Any books or periodicals may be borrowed other than those constantly required for reference.
2. The loan period is three weeks, but this may be extended if others are not waiting for the work in question.
3. The Institution bears the outward cost of postage.
4. Members are responsible for the care of books in their possession, and will be asked to replace any lost or damaged. Books must be returned securely wrapped.

There is no rule about the number of books which may be borrowed at one time, though the staff may sometimes have to impose a limit. Additions to the Library are listed each month in the Journal.

news of members

Mr. Harold Burke, Member, Director of Concentric Manufacturing Co. Ltd., Birmingham, has been elected Chairman of their newly-acquired company, Fletcher Bros. (Pressings) Ltd., also of Birmingham. Mr. Burke, who is Chairman of the Institution's Midlands Region, is a past Chairman of Council and serves on the Finance and General Purposes Committee.

Mr. J. E. Burnett, Member, formerly acting as Consultant with Tube Investments (Group Services) Limited, has been appointed Director and General Manager of Swallow Coachbuilding Co. (1935) Limited, one of the Tube Investments Group of Companies.

Mr. T. P. N. Burness, Member, has retired from his position as Joint Managing Director of William Asquith, Ltd., of Halifax. Mr. Asquith, who now lives in Lincolnshire, has been a director of the Asquith Machine Tool Corporation, Ltd., and Managing Director of Modern Foundries Ltd., since 1939. He retains his position on the Corporation Board. He is also Chairman of Ambrose, Shardlow & Co. Ltd., of Sheffield.

Mr. F. Grimshaw, O.B.E., Member, General Works Engineer of Leyland Motors Ltd., is visiting India to advise on the preparation for the manufacture of Leyland vehicles there. This will be carried out in Madras, at the factory of the newly-constituted company, Ashok-Leyland, Ltd. Mr. Grimshaw is Vice-Chairman of the Preston Section, and also serves on the Institution's Papers Committee as a Corresponding Member.

Mr. F. R. Humphrey, Member, of the Tyburn Road Works of Concentric Manufacturing Co. Ltd., Birmingham, has been recommended for election to the Board.

Mr. M. G. Lane, Member, Production Manager of Hoover (Washing Machines) Ltd., Merthyr Tydfil, has just completed 25 years' service with Hoover Limited, and has joined the company's " Quarter Century Club ". He has been presented with a gold watch by the Company's Managing Director, Mr. S. Roberts.

Mr. F. P. Laurens, O.B.E., Member, formerly General Manager of Vickers-Armstrongs Engineering Works and Shipyard at Barrow, has been appointed Managing Director of Powers-Samas Accounting Machines, Ltd. Mr. Laurens is a Director of Vickers-Armstrongs, Ltd., and has been associated with the Vickers Group of Companies since 1916, when he

commenced his engineering apprenticeship at Erith Works.

He is a past President of the London Section of the Institution, and recently became a Liveryman of the Worshipful Company of Shipwrights.

Mr. W. D. Opher, Member, has been appointed General Manager of Vickers-Armstrongs Engineering Works and Shipyard at Barrow. He was formerly General Manager of the North-Eastern Works of Vickers-Armstrongs.

Mr. Opher has been with the company for 27 years, and joined the board in 1952. He was a member of the North Eastern Section Committee of the Institution, and before going North served for some years on the London Section Committee.

Mr. C. W. Roberts, Member, has now returned to London and has rejoined his old firm of Sparklets Limited.

Mr. R. Swift, Member, has been appointed Managing Director of Gent & Co. Ltd., where he began his career in 1920. After a short period with Taylor, Taylor & Hobson, Ltd., and T. Grieve & Co. Ltd., as a toolmaker, he returned to Gent & Co. Ltd., in 1928 as machine shop foreman. In 1940 he was made Production Manager and two years later became Works Manager. He was appointed Works Director in 1946.

Mr. J. H. Bostock, Associate Member, has relinquished his position as Chief Product Development Engineer (Switchgear) with the English Electric Co. Ltd., Stafford, and has taken up an appointment with The Climax Rock Drill & Engineering Works Limited, as Production Engineer.

Mr. M. D. J. Brisby, Associate Member, has recently relinquished his position with British Iron & Steel Research Association, to take up an appointment with the Iron & Steel Board, London.

Mr. W. E. Fowler, Associate Member, has been appointed Works Manager of Hordern-Richmond Limited, having formerly been Chief Planning Engineer of Permali Limited, Gloucester, for 16 years.

Mr. F. T. Jones, Associate Member, has recently been appointed Production Manager of Hunting Percival Aircraft Limited, Luton.

Mr. A. McCaskie, Associate Member, has accepted a Post as Departmental Manager with The Tempered Spring Company Ltd., Sheffield.

Mr. L. H. Osborne, Associate Member, has been transferred to the Headquarters of the Central Electricity Authority as Senior Assistant Design Engineer.

Mr. G. R. Parker, Associate Member, has recently taken up an appointment as Projects Engineer with Messrs. K. & L. Steelfounders & Engineers Ltd., Letchworth. Mr. Parker was Section Secretary of the Manchester Section for some years.

Mr. Geoffrey Pitt, Associate Member, is now studying in the School of Business of the University of Chicago for the Degree of Master of Business Administration.

Mr. D. N. Singh, Associate Member, Assistant Professor of Mechanical Engineering, Bihar College of Engineering, Patna, India, has joined the Department of Aeronautics & Fluid Mechanics of the University of Glasgow as a research student.

Mr. L. E. Watts, Associate Member, has taken up a new appointment as Works Manager with Millar's Machinery Co. Ltd., Bishop's Stortford.

Mr. R. T. Williams, Associate Member, has relinquished his position with British Timken Limited, and has taken up an appointment as Works Manager with The Clifford Machine Tool Co. Ltd., Birmingham.

Mr. D. W. Birchmore, Graduate, has changed his position with Vauxhall Motors Limited, Luton. He was previously a Technical Instructor at the Luton Factory and has now taken up the position as Education Liaison Officer at the Dunstable factory.

Mr. E. A. Freeman, Graduate, has relinquished his position with Joseph Lucas Limited to join the research staff at the Experimental Division of the Ford Motor Co. Ltd., Birmingham, in their Tractor Research Department as a Design Draughtsman.

Mr. P. W. Lambert, Graduate, has recently been appointed to the position of Assistant Production Engineer, with Messrs. Norris Industrial Consultants Limited.

Mr. F. E. Letchford, Graduate, has relinquished his position at The Monotype Corporation Limited, and has taken up an appointment as Mechanical Design Engineer at The Morgan Crucible Company Limited.

Mr. J. E. Lloyd, Graduate, is now employed as an Engineer B in the Special Weapons Department, Canadair Limited, Montreal.

Mr. K. G. H. Williams, Graduate, has taken up an appointment in the Work Study Department of the Mullard Radio Valve Company, Mitcham. He was previously with the Armament Department of the Royal Aircraft Establishment, Farnborough.

JOURNAL CONTENTS

VOL. 34, 1955

January

page

" Education and Research for Production " by H. W. Wright-Baker, D.SC., M.I.MECH.E. ... 1
" The Development and Manufacture of Jig Boring Machinery " by W. H. Jaye, B.SC.ENG.(LOND) 5
" What is Good Design?" by Sir Walter Puckey, M.I.PROD.E., F.I.I.A. 17
New Building Fund Appeal ... 27
" Development of Machine Production in the Shoe Industry " by J. H. Britton, J.P. 28
" Colour Printing Process and Production in a Printing Industry " by H. J. Jarrold 32
" Time, Space and Productivity " by A. B. Waring 36
The 1955 Associate Membership Examination 39
Institution Notes 40
" The Automatic Factory—What Does It Mean?" 41
News of Members 43
Hazleton Memorial Library ... 44
Periodicals Currently Received ... 46
Notice of Annual General Meeting, 27th January, 1955 48
Minutes of Annual General Meeting, 28th January, 1954 ... 48
Report on Election of Members to Council, 1954/55 49
Report of Council, 1st July, 1953 to 30th June, 1954 50

February

" Education and Research for Production "—Address by Lord Hives, C.H., M.B.E., D.SC., LL.D., at the Annual Dinner of the City and Guilds College ... 65
The 1954 Viscount Nuffield Paper
" The Corps of Royal Electrical and Mechanical Engineers and the Application of Modern Management and Production Techniques" by Major-General W. A. Lord, C.B., C.B.E., M.ENG., M.I.MECH.E., M.I.E.E. 68
Report and Discussion ... 79
" Automatic Transfer Production " by Frank G. Woollard, M.B.E., M.I.MECH.E., M.I.PROD.E., M.I.I.A., M.S.A.E. 85
" Automation " — A Select Bibliography 100
" A Job Evaluated Wages Structure " by R. N. Marland, B.SC., A.M.I.MECH.E., M.I.PROD.E. 102
" Modern Cold Rolling Mills " by G. W. Ashton 111
Institution Notes 120
" The Automatic Factory—What Does It Mean?" 121
News of Members 122
Hazleton Memorial Library ... 123
New Building Fund Appeal ... 123

March

page

" Education and Research for Production " by Professor E. J. Richards, M.A., B.SC. 129
Third Conference on Problems of Production
Programme 132
Session I. " Aircraft Design Problems and Trends " by A. E. Woodward-Nutt, M.A., F.R.AE.S. 133
Discussion 146
Conference Luncheon ... 149
Session II (i) " Problems of Forging " by G. W. Richards ... 152
Session II (ii) " Machining and Forming Problems of Integral Construction " by E. D. Keen, B.SC.(ENG.), F.R.AE.S. and A. W. Menzies 158
Joint Discussion 180
Report of the Annual General Meeting, January, 1955 ... 189
Report of the Meeting of Council, January, 1955 190
Election of Members 192
Extracts from Local Section Reports 193
News of Members 197

April

" Education and Research for Production " by C. L. Old, B.SC.(ENG.), A.C.G.I., M.SC.(TECH.), M.INST.C.E., M.I.MECH.E., M.I.PROD.E. ... 201
Third Conference on Problems of Aircraft Production
Programme 204
Session III. " High Speed Machine Tools for Aircraft Production " by S. Radcliffe, B.SC.(TECH.), A.M.I.MECH.E., M.I.PROD.E. 205
Discussion 224
Session IV. " Where Do We Go From Here?" by W. E. W. Petter, C.B.E., B.A., F.R.AE.S. ... 227
"The Industrial Uses of ' Terylene ' Polyester Fibre " by D. N. Marvin 231
"A Quarter-Century of Progress in Ford Production Methods " by J. McNulty 239
Institution Notes 249
News of Members 251
Hazleton Memorial Library ... 252

May

" Education and Research for Production " by K. J. Hume, B.SC., M.I.MECH.E., M.I.PROD.E. 261
" The Basic Nomenclature of Cutting Tools " by G. V. Stabler, B.SC., M.I.MECH.E., M.I.PROD.E., M.I.E.I. 264

page

" The Significance of Machine Tools in the Australian Economy " by H. Grafton, DIPL., A.M.I.E(AUST.), A.M.I.MECH.E., A.M.I.PROD.E. ... 280
" The Practical Uses of Electronics in Industry " by K. A. Zandstra, A.M.I.E.E. 288
" Training in Work Study, with detailed reference to the Case Study Method in Applied Work Study " by J. Purcell, A.M.I.PROD.E. 305
" Ultrasonic Tools for Hard-to-Materials " by J. P. Aloisio and N. Clark, Jr. 315
Notice of Council Elections, 1955/56 320
Institution Notes 321
News of Members 322
Hazleton Memorial Library ... 323

June

" Automation in the United Kingdom " 331
" Compressed Air in Aircraft Production—A User's Experience " by W. E. Wright, A.F.R.AE.S., A.M.I.MECH.E., A.M.I.PROD.E. ... 334
" Production Methods in Railway Workshops " by T. B. Maddison, B.E.M., A.M.I.PROD.E., M.I.LOCO.E. 356
" Some Provocative Thoughts on Aircraft Tooling Methods " by S. P. Woodley, M.B.E. 378
Report of the Meeting of Council, April, 1955 387
Elections and Transfers ... 389
Extracts from Local Section Reports 390
Institution Notes 395
News of Members 397
Hazleton Memorial Library ... 398

July

Sir Leonard Lord, K.B.E., President of the Institution, 1955/56, 503, 480
" The Automatic Factory—What Does It Mean?" (Margate Conference)
First Plenary Session. " The Automatic Factory — Dream or Nightmare?" by Sir Walter Puckey 406
Discussion Group 1A. " The Automatic Mechanical Project Factory—A Sight of Things to Come " by H. J. Graves, M.I.PROD.E. 421
Discussion Group 1B. " Automation —Some Problems for the Manager " by F. Garner, M.I.MECH.E. 431
Discussion Group 1C. " The Computer — Electronics' Contribution to Production " by R. H. Booth 442

page

Discussion Group 3*A*. "Atoms, Electrons and Automation" by A. G. Peacock, B.SC., A.R.I.C., M.INST.P. 449
Conference of Standards Engineers, 4th May, 1955 457
The 1954 *George Bray Memorial Lecture*
"Engineering and Production Aspects of Synthetic Fibre Manufacture" by Robert Douglas, M.B.E., M.I.PROD.E. ... 460
Report of Meeting and Discussion 476
The Principal Officers, 1955/56 ... 480
Council Elections, 1955/56 ... 441
News of Members 481

August

Presentation to Sir Walter Puckey 489
Margate Conference Papers
Second Plenary Session. "Technical and Human Problems of the Automatic Factory" by the Rt. Hon. The Earl of Halsbury, F.R.I.C., F.INST.P. 496
Discussion Group 1*D*. "The Engineer and the Automatic Factory—A Challenge to the Technical College" by C. L. Old, B.SC.(ENG.), A.C.G.I., M.SC.(TECH.), M.INST.C.E., M.I.MECH.E., M.I.PROD.E., A.F.R.AE.S. 501
Discussion Group 1*E*. "The Automatic Factory—The Age of Harmony, Leisure and Plenty?" by Professor B. R. Williams, B.A.(MELB.), M.A.(ADE.) ... 510
Discussion Group 2*A*. "Automatic Transfer Machines" by P. Bezier 517
Discussion Group 2*B*. "Automation—Some Problems for the Boardroom" by M. Seaman, M.SC., M.I.MECH.E., M.I.PROD.E. ... 535
Discussion Group 2*D*. "Automatic Control in the Petroleum Industry—A Case Study" by I. McCallum, B.SC. 539
New Building Fund Appeal ... 546
News of Members 547
Hazleton Memorial Library ... 550

September

Margate Conference Papers
Third Plenary Session. "Machines in the Service of Man" by F. G. Woollard, M.B.E., M.I.MECH.E., M.I.PROD.E., M.I.I.A., M.S.A.E. ... 555

page

Discussion Group 2*C*. "Automatic Inspection—The Anatomy of Conscious Machines" by J. A. Sargrove, M.I.E.E., M.BRIT.I.R.E., and Peter Huggins, A.M.BRIT.I.R.E. 563
Discussion Group 4*D*. "Automatic Electronic Control of Machine Tools" by J. A. Stokes, B.SC., A.M.I.E.E. 575
Discussion Group 2*E*. "The Engineer and the Automatic Factory—A Challenge to the University" by Professor T. U. Matthew, PH.D. (CANTAB.), M.SC.(B'HAM), B.SC.(LONDON), A.R.T.C.(GLASGOW) 582
Discussion Group 3*B*. "The Automatic Factory—How Will The Trades Unions React?" by E. Fletcher 589
Discussion Group 3*C*. "The Automatic Office—Industry's Automatic Pulse" by D. W. Hooper, M.A., A.C.A. 595
Discussion Group 4*B*. "Automatic Linking Devices" by J. A. Hunt, M.B.E., M.I.I.A., and J. B. Jay, A.M.I.MECH.E. 602
Report of the Meeting of Council, July, 1955 622
The Standing Committees, 1955/56 625
Elections and Transfers ... 626
Extracts from Local Section Reports 627
The Schofield Scholarships, 1956 631
Higher Degrees in Engineering Production 632
Practical Lectures—A Successful Experiment 633
News of Members 634

October

Higher Technological Education—Report of the Council Discussion held in July, 1955 ... 639
Margate Conference Papers
Discussion Group 3*D*. "Computer-controlled Machine Tools" by D. T. N. Williamson 649
Discussion Group 4*C*. "Prerequisites of the Automatic Chemical Factory" by A. J. Young, B.A., B.SC. 659
Discussion Group 4*A*. "Automatic Selection, Weighing and Conveying—Quality and Quantity by Remote Control" by P. Bourgeois 670
"Plastics — Materials, Processes and Plant" by D. C. Nicholas 676
"Some Aspects of Education for Production Engineering" by H. Dodd, A.M.I.PROD.E. 692

page

"Medical and Industrial Rehabilitation in Great Britain" by T. M. Ling, M.D., M.R.C.P. 695
"Production Control in Industry" by F. G. S. English, M.I.PROD.E. 697
The 1955 Schofield Scholars ... 700
News of Members 701
Hazleton Memorial Library ... 703

November

"Designing for Production—The Motor Car" by Sir Leonard Lord, K.B.E., President of the Institution 711
"Gas Turbines — Basic Principles and Production Problems" by C. E. Wurr 714
"Progress of British Clock and Watch Production" by R. Lenoir 731
"The Accountant in Production Engineering" by J. R. Harrowell, F.I.C.A.(AUST.) 739
"Industrial Metal Finishing Technique and Practice—Paints and Organic Coatings" by J. J. Stordy, B.SC., and W. G. J. Appleton, A.M.I.MECH.E., M.INST.F. 752
News of Members 770
Hazleton Memorial Library ... 771

December

"Designing for Production — Production of Consumer Goods" by B. H. Dyson, I.PROD.E., F.I.I.A. 775
"Productivity in the Manufacture of Worm Gear Units" by F. J. Everest, M.SC., A.C.G.I., D.I.C., M.I.MECH.E., A.M.I.E.E., M.I.PROD.E., A.I.MECH.E. ... 778
"Gear Measurement and Allied Subjects" by C. Timms, M.ENG., M.I.MECH.E., M.I.PROD.E. 792
"Materials Handling" — A Series of Case Studies ... 805
The Annual Dinner, 1955 ... 808
Report of the Meeting of Council, October, 1955 ... 812
"Automation—The Institution's Policy" 815
Election of Members 820
Extracts from Local Section Reports 821
Institution Notes 828
The Hazleton Memorial Library 829
News of Members 830
Journal Contents, Vol 34, 1955 832
Subject Index to Papers published January/December, 1955 834

SUBJECT INDEX TO PAPERS PUBLISHED JANUARY/DECEMBER 1955

Accountancy
"The Accountant in Production Engineering" by J. R. Harrowell 739

Aircraft
"Aircraft Design Problems and Trends" by A. E. Woodward-Nutt.
(Aircraft Production Conference, No. 3, Southampton, 1955) 133
"High Speed Machine Tools for Aircraft Production" by S. Radcliffe.
(Aircraft Production Conference, No. 3, Southampton, 1955) 205
"Machining and Forming Problems of Integral Construction" by E. D. Keen and A. W. Menzies.
(Aircraft Production Conference, No. 3, Southampton, 1955) 158
"Some Provocative Thoughts on Aircraft Tooling Methods" by S. P. Woodley 378
"Where do we go from Here?" by W. E. W. Petter.
(Aircraft Production Conference, No. 3, Southampton, 1955) 227

Army
"The Corps of Royal Electrical and Mechanical Engineers and the Application of Modern Management and Production Technique" by W. A. Lord.
(The 1954 Viscount Nuffield Paper) 68

Australia
"The Significance of Machine Tools in the Australian Economy" by H. Grafton 280

Automatic Linkages
"Automatic Linking Devices" by J. A. Hunt and J. B. Jay. ("The Automatic Factory—What Does It Mean?")
(National Conference, Margate, 1955) 602

Automatic Weighing
"Automatic Selection, Weighing and Conveying" by P. Bourgeois. ("The Automatic Factory—What Does It Mean?")
(National Conference, Margate, 1955) 670

Automation
see also: Automatic Inspection; Automatic Linkages; Automatic Weighing; Electronic Computers; Electronic Control; Machine Tool Control, Electronic; Transfer Machines.
"Automatic Control in the Petroleum Industry—A Case Study" by I. McCallum. ("The Automatic Factory—What Does It Mean?")
(National Conference, Margate, June, 1955) 539
"The Automatic Factory—Dream or Nightmare?" by Sir Walter Puckey. ("The Automatic Factory—What Does It Mean?")
(National Conference, Margate, 1955) 406
"The Automatic Factory—How Will Trades Unions React?" by E. Fletcher. ("The Automatic Factory—What Does It Mean?")
(National Conference, Margate, 1955) 589
"The Automatic Factory—The Age of Harmony, Leisure and Plenty?" by B. R. Williams. ("The Automatic Factory—What Does It Mean?")
(National Conference, Margate, 1955) 510
"The Automatic Factory—What Does It Mean?"
(National Conference, Margate, 1955. Papers) 406, 421, 431, 442, 449, 496, 501, 510, 517, 535, 539, 555, 563, 575, 582, 589, 595, 602, 649, 659, 670
"Automatic Mechanical Project Factory—A Sight of Things to Come" by H. J. Graves. ("The Automatic Factory—What Does It Mean?")
(National Conference, Margate, 1955) 421
"Automation—Some Problems for the Boardroom" by M. Seaman. ("The Automatic Factory—What Does It Mean?")
(National Conference, Margate, 1955) 535
"Automation—Some Problems for the Manager" by F. Garner. ("The Automatic Factory—What Does It Mean?")
(National Conference, Margate, 1955) 431
"The Engineer and The Automatic Factory—A Challenge to the Technical College" by C. L. Old. ("The Automatic Factory—What Does It Mean?")
(National Conference, Margate, 1955) 501
"The Engineer and The Automatic Factory—A Challenge to the University" by T. U. Matthew. ("The Automatic Factory—What Does It Mean?")
(National Conference, Margate, 1955) 582
"Machines in the Service of Man" by Frank G. Woollard. ("The Automatic Factory—What Does It Mean?")
(National Conference, Margate, 1955) 555
"Prerequisites of the Automatic Chemical Factory" by A. J. Young. ("The Automatic Factory—What Does It Mean?")
(National Conference, Margate, 1955) 659
"Technical and Human Problems of the Automatic Factory" by the Earl of Halsbury. ("The Automatic Factory—What Does It Mean?")
(National Conference, Margate, 1955) 496

Automobiles
"Designing for Production—The Motor Car" by Sir Leonard Lord 711
"A Quarter-century of Progress in Ford Production Methods" by J. McNulty 239

Boots
see: Shoes and Boots.

Clocks and Watches
"Progress of British Clock and Watch Production" by R. Lenoir 731

Colour Printing
see: Printing, Colour.

Compressed Air
"Compressed Air in Aircraft Production—A User's Experience" by W. E. Wright.
(Compressed Air Conference, Camborne, 1955) 334

Computers, Electronic
see: Electronic Computers.

Cutting Tools
see: Tools, Cutting.

Design
"What is Good Design?" by Sir Walter Puckey 17

Disabled Workers
"Medical and Industrial Rehabilitation in Great Britain" by T. M. Ling 695

Education
see also: Work Study—Training.
"Education and Research for Production" by K. J. Hume 261
"Education and Research for Production" by C. L. Old 201
"Education and Research for Production" by H. W. Wright-Baker 1
"Education and Research for Production" (discussion of the findings of the 3rd Aircraft Production Conference) by E. J. Richards 129
"Education and Research for Production" (Speech at the Annual Dinner of Old Centralians and City and Guilds College) by Lord Hives 65
"The Engineer and The Automatic Factory—A Challenge to the Technical College" by C. L. Old. ("The Automatic Factory—What Does It Mean?")
(National Conference, Margate, 1955) 501
"The Engineer and The Automatic Factory—A Challenge to the University" by T. U. Matthew. ("The Automatic Factory—What Does It Mean?")
(National Conference, Margate, 1955) 582
"Some Aspects of Education for Production Engineering" by H. Dodd 692

Electronic Computers
" The Automatic Office—Industry's Electronic Pulse " by Dudley W. Hooper. (" The Automatic Factory—What Does It Mean?")
(*National Conference, Margate, 1955*) 595
" Computer-controlled Machine Tools " by D. T. N. Williamson. (" The Automatic Factory—What Does It Mean?")
(*National Conference, Margate, 1955*) 649
" The Computer—Electronics' Contribution to Production " by R. H. Booth. (" The Automatic Factory—What Does It Mean?")
(*National Conference, Margate, 1955*) 442

Electronic Control
see also: Electronic computers; Machine tool control, electronic.
" Atoms, Electrons and Automation " by A. G. Peacock. (" The Automatic Factory—What Does It Mean?")
(*National Conference, Margate, 1955*) 449

Electronics
see also: Electronic Computers; Electronic Control; Machine Tool Control, Electronic.
" The Practical Uses of Electronics in Industry " by K. A. Zandstra 288

Fibres, Synthetic
see also: Terylene.
" Engineering and Production Aspects of Synthetic Fibre Manufacture " by R. Douglas. (The 1954 George Bray Memorial Lecture) 460

Finishing
" Industrial Metal Finishing Technique and Practice—Paints and Organic Coatings " by J. J. Stordy and W. G. J. Appleton 752

Ford Motor Company, Dagenham
" A Quarter-century of Progress in Ford Production Methods " by J. McNulty 239

FORGING
" Problems of Forging " by G. W. Richards.
(*Aircraft Production Conference, No. 3, Southampton, 1955*) ... 152

Gas Turbines
" Gas Turbines—Basic Principles and Production Problems " by C. E. Wurr 714

Gears—Measurement
" Gear Measurement and Allied Subjects " by C. Timms 792

Inspection, Automatic
see: Automatic inspection.

Integral Construction
" Machining and Forming Problems of Integral Construction " by E. D. Keen and A. W. Menzies.
(*Aircraft Production Conference, No. 3, Southampton, 1955*) ... 158

Jig Boring Machinery
" The Development and Manufacture of Jig Boring Machinery " by W. H. Jaye 5

Job Evaluation
" A Job-evaluated Wages Structure " by R. N. Marland 102

Labour Costs
" Time, Space and Productivity " by A. B. Waring ... 36

Machine Shop Practice
" Some Provocative Thoughts on Aircraft Tooling Methods " by S. P. Woodley 378

Machine Tool Control, Electronic
" Automatic Electronic Control of Machine Tools " by J. A. Stokes. (" The Automatic Factory—What Does It Mean?")
(*National Conference, Margate, 1955*) 575
" Computer-controlled Machine Tools " by D. T. N. Williamson. (" The Automatic Factory—What Does It Mean?")
(*National Conference, Margate, 1955*) 649

Machine Tools
" High Speed Machine Tools for Aircraft Production " by S. Radcliffe.
(*Aircraft Production Conference, No. 3, Southampton, 1955*) ... 205
" The Significance of Machine Tools in the Australian Economy " by H. Grafton 280

Machining, Ultrasonic
" Ultrasonic Tools for Hard-to-machine Materials " by J. P. Aloisio and N. Clark, Jr. 315

Management
" The Corps of Royal Electrical and Mechanical Engineers and the Application of Modern Management and Production Techniques " by W. A. Lord. (The 1954 Viscount Nuffield Paper) 68

Nomenclature—Cutting Tools
see: Tools, Cutting—Nomenclature.

Petroleum Refining
" Automatic Control in the Petroleum Industry—A Case Study " by I. McCallum. (" The Automatic Factory—What Does It Mean?")
(*National Conference, Margate, 1955*) 539

Plastics
see also: Terylene.
" Plastics—Materials, Processes and Plant " by D. C. Nicholas 676

Printing, Colour
" Colour Printing Process and Production in a Printing Industry " by H. J. Jarrold 32

Production Planning and Control
"Production Control in Industry " by F. G. S. English ... 697

Railway Workshops
" Production Methods in Railway Workshops " by T. B. Maddison 356

Research
" Education and Research for Production " by K. J. Hume 261
" Education and Research for Production " by C. L. Old 201
" Education and Research for Production " by H. W. Wright-Baker 1
" Education and Research for Production " (discussion of the findings of the 3rd Aircraft Production Conference) by E. J. Richards 129
" Education and Research for Production " (speech at the Annual Dinner of Old Centralians and City and Guilds College) by Lord Hives 65

Rolling Mills
" Modern Cold Rolling Mills " by G. W. Ashton ... 111

Royal Electrical and Mechanical Engineers
" The Corp of Royal Electrical and Mechanical Engineers and the Application of Modern Management and Production Techniques " by W. A. Lord. (The 1954 Viscount Nuffield Paper) 68

Shoes and Boots
" Development of Machine Production in the Shoe Industry " by J. H. Britton 28

Synthetic Fibres
see: Fibres, synthetic; Terylene.

Terylene
" The Industrial Uses of ' Terylene ' Polyester Fibre " by D. N. Marvin 231

Tools, Cutting—Nomenclature
" The Basic Nomenclature of Cutting Tools " by George V. Stabler 264

Trade Unions
" The Automatic Factory—How Will The Trades Unions React?" (" The Automatic Factory—What Does It Mean?")
(*National Conference, Margate, 1955*) 589

Transfer Machines
" Automatic Transfer Machines " by P. Bezier. (" The Automatic Factory—What Does It Mean?")
(*National Conference, Margate, 1955*) 517
" Automatic Transfer Production " by Frank G. Woollard 85

Ultrasonic Machining
see: Machining, Ultrasonic.

Wages and Salaries
" A Job-evaluated Wages Structure " by R. N. Marland 102

Work Study—Training
" Training in Work Study with detailed reference to the case study method in Applied Work Study " by J. Purcell 305

Workshop Technology—Railway workshops
see: Railway workshops.

Worm Gears
" Productivity in Worm Gear Unit Manufacture " by F. J. Everest 778

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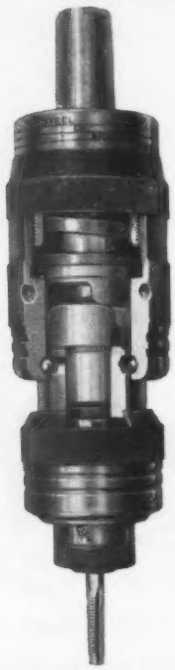

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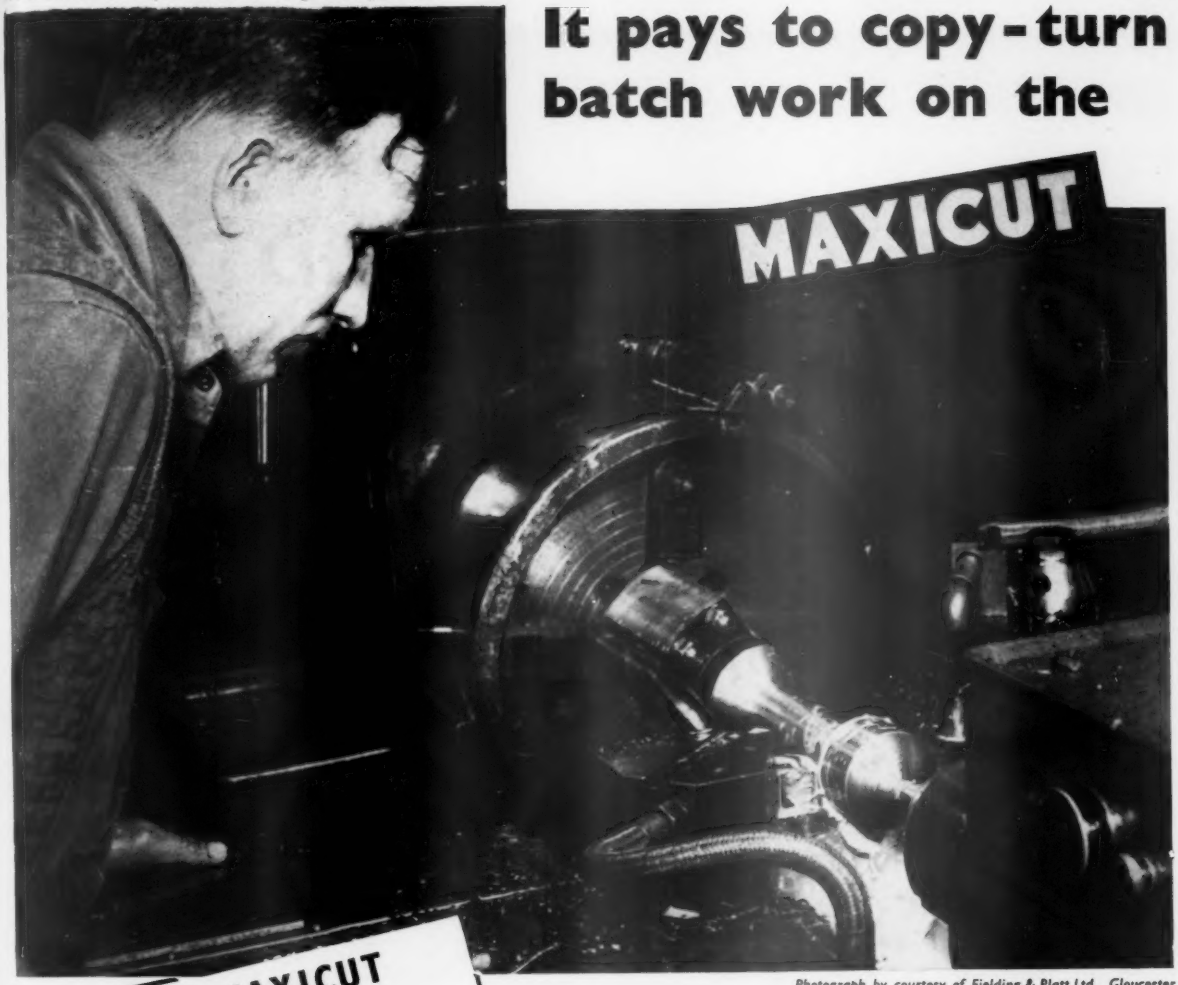

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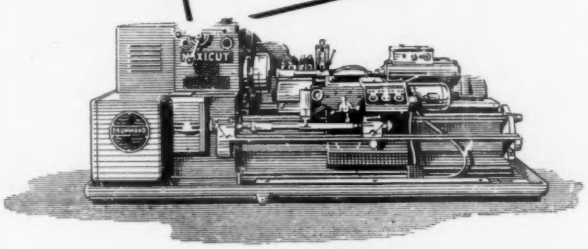

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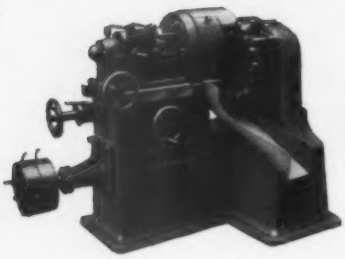

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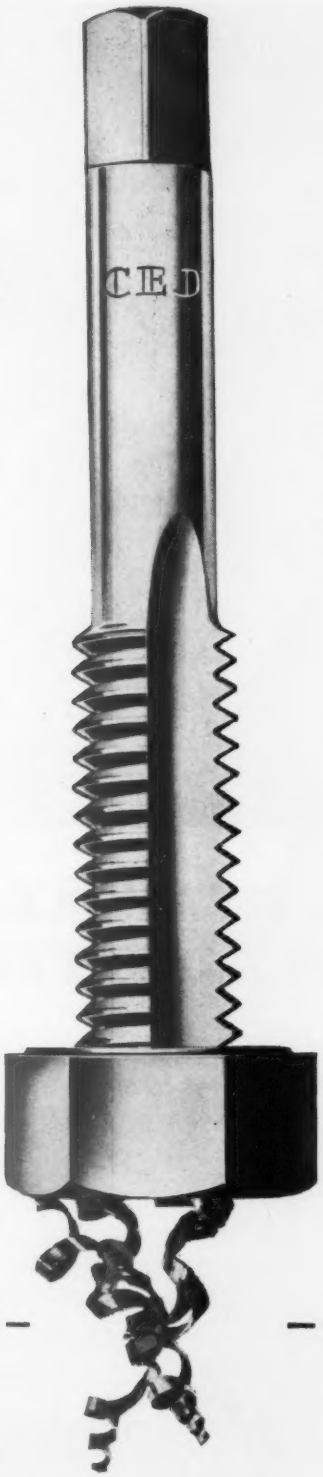

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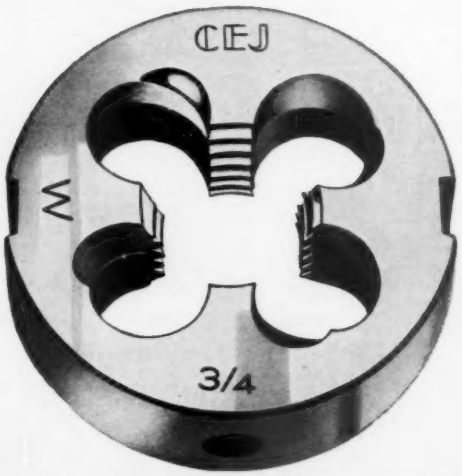

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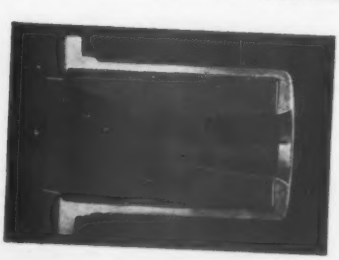

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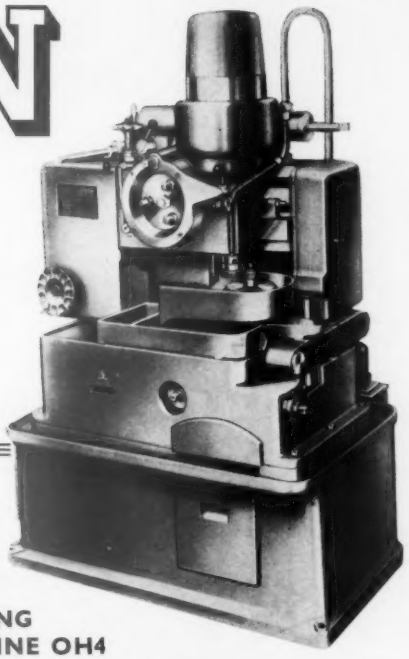
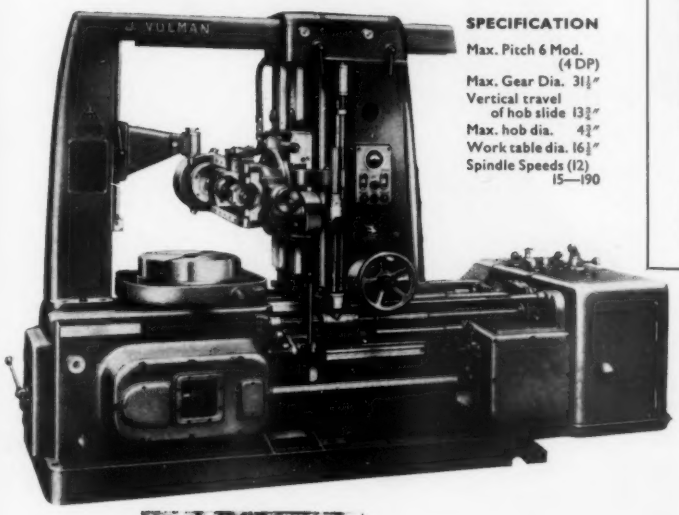
GEAR HOBBING
GEAR MILLING
MACHINES



GEAR HOBBING MACHINE FO6

The heavy duty Volman Gear Hobbers are unexcelled for high rate production of precision spur, helical and worm gears. Tangential head available for cutting worm wheels.



SPECIFICATION

Max. Pitch 6 Mod. (4 DP)
Max. Gear Dia. 31½″
Vertical travel of hob slide 13½″
Max. hob dia. 4½″
Work table dia. 16½″
Spindle Speeds (12) 15—190

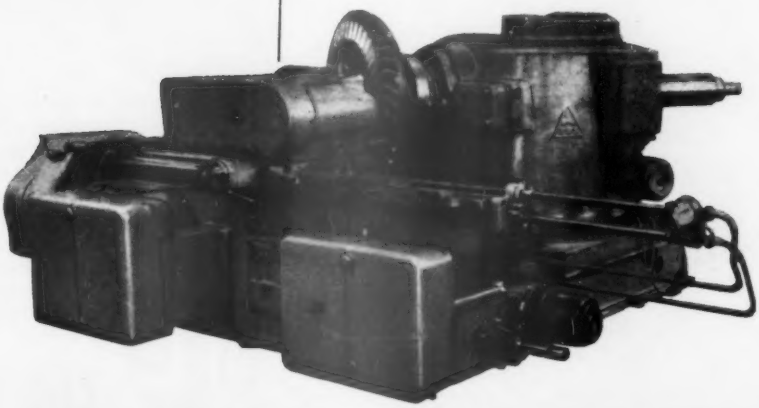
GEAR SHAPING MACHINE OH4

For rapid production of internal and external spur, single and double helical gears, segment gears, ratchets, cams.

SPECIFICATION	*External*	*Internal*
Max. dia. of spur gears	7½″	6½″
Max. dia. of helical gears	7½″	6½″
Min. gear diameter	¾″	1¼″
Max. gear width	1⅛″	1⅛″
Max. Pitch 4 Mod. (6 DP)		

GEAR MILLING MODEL OKU 35

Spur and Bevel Gears up to maximum diameter of 86½″, maximum pitch 35 module. Model OKU 50 also available — maximum capacity 197″ diameter, maximum pitch 50 module.



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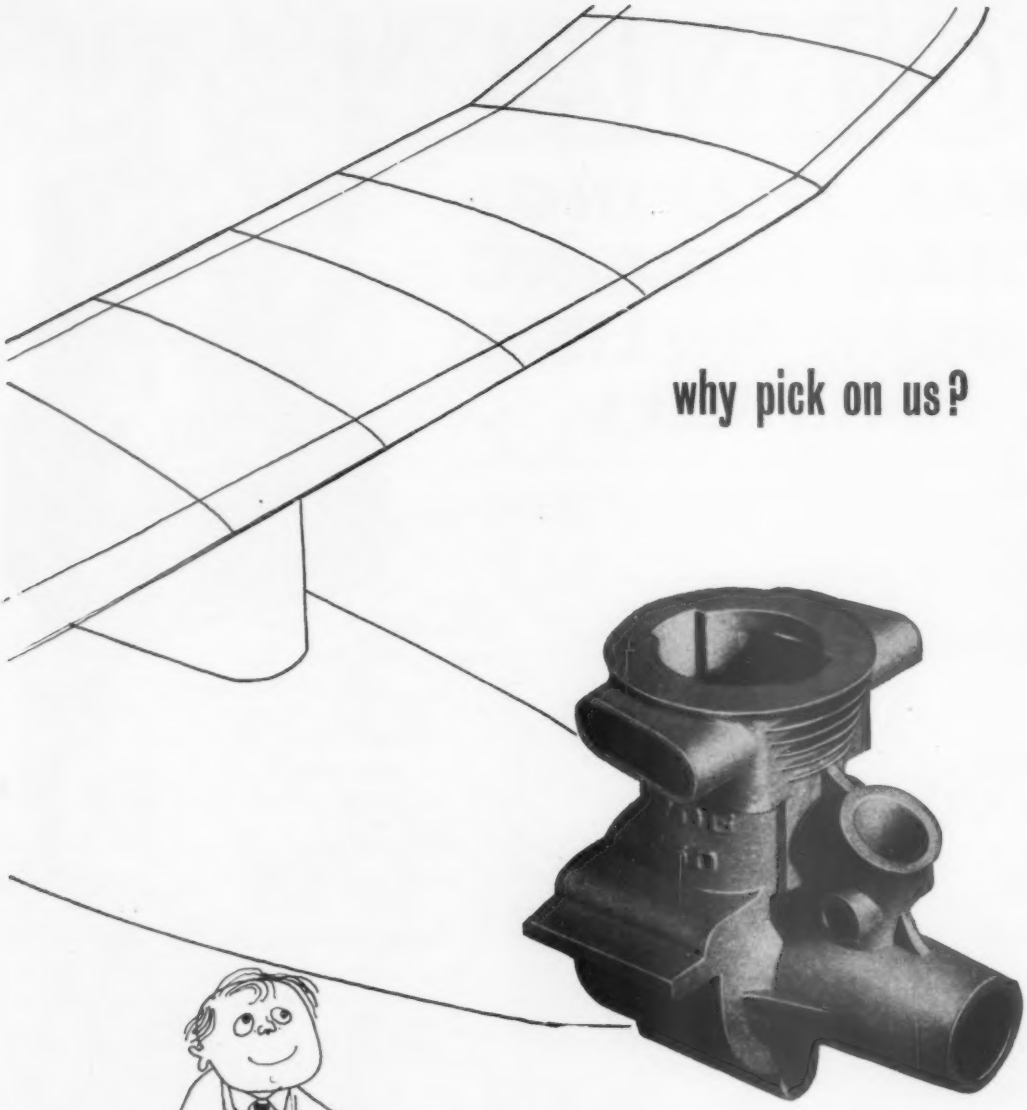

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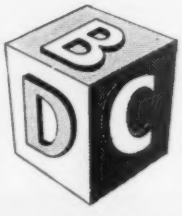

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CEC 29

press on to greater production

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Production engineers want ACTION at the push of a button — simple, safe, sure action at the finger tips of every operator all along the line.

This is why more and more machine tool makers specify Igranic motor control gear. Throughout the range — from the standard starter or simple auxiliary switch, to the specially designed multi-motor control panel — Igranic control gear displays a characteristic dependability in service which has long been recognised by the discriminating designer of machine tools and other production plant.

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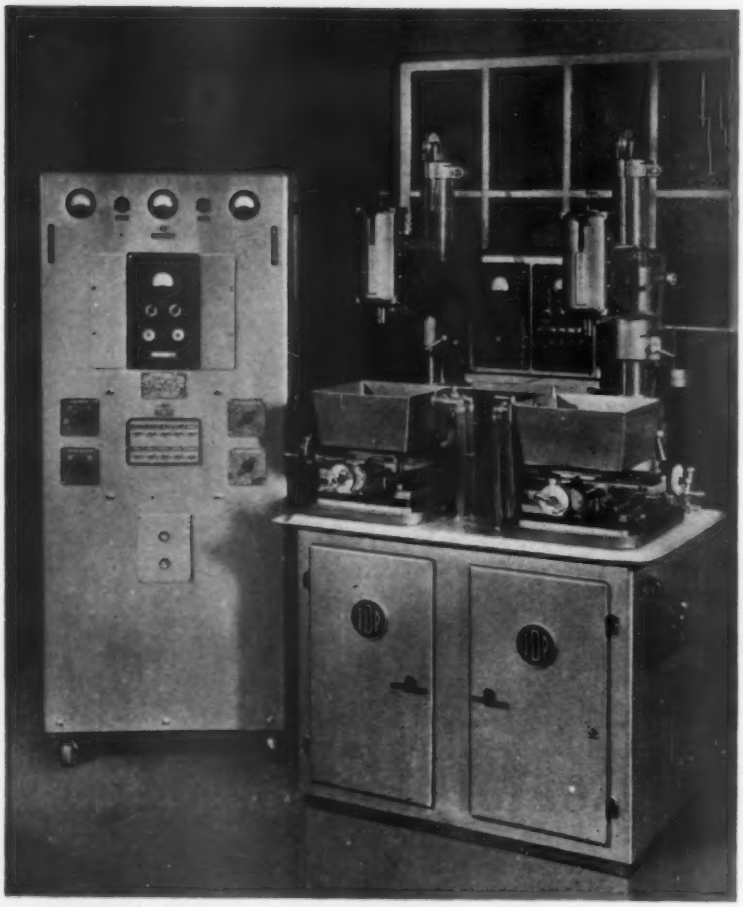


For production of all types of dies and form tools.

The leading manufacturers of spark machining equipment in the world, have pleasure in announcing their latest

SPARCATRON Mk. II Model

With double head.

This addition to the Sparcatron range of machines for spark machining has been produced as the result of requests for an equipment for use with large section electrodes to be operated to very close limits, and can be supplied with two heads as illustrated, or with a single head.

The twin head model can be easily worked by one operator, and the heads operated separately, so that production per man hour is doubled.

A further two or more heads may be used in conjunction with the main control unit in some circumstances.

Manufactured by:

IMPREGNATED DIAMOND PRODUCTS LTD., GLOUCESTER, ENGLAND

TELEPHONE 21164 (3 LINES) TELEGRAMS IMPREG GLOUCESTER

~~HIGH SPEED~~

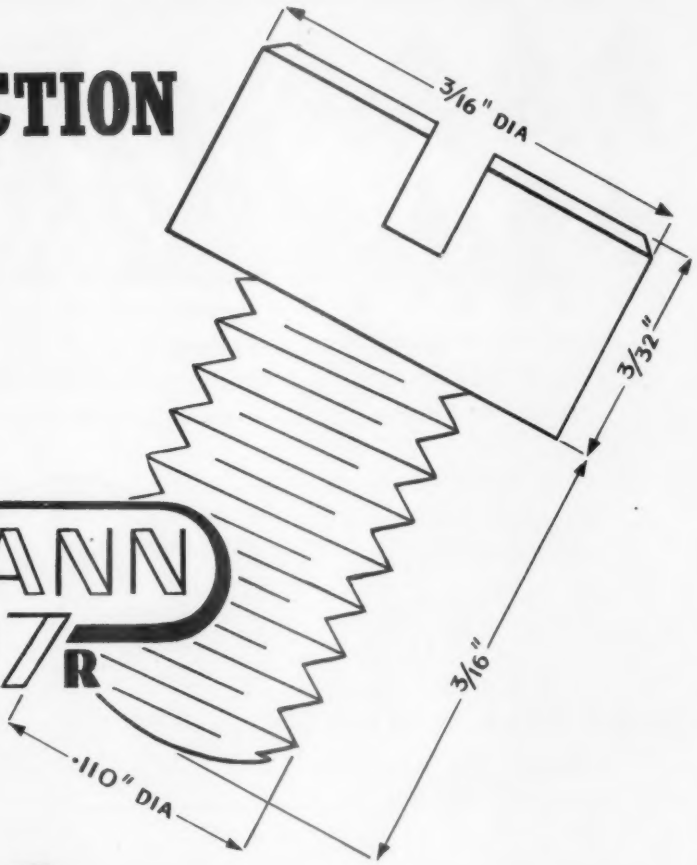
SCREW PRODUCTION

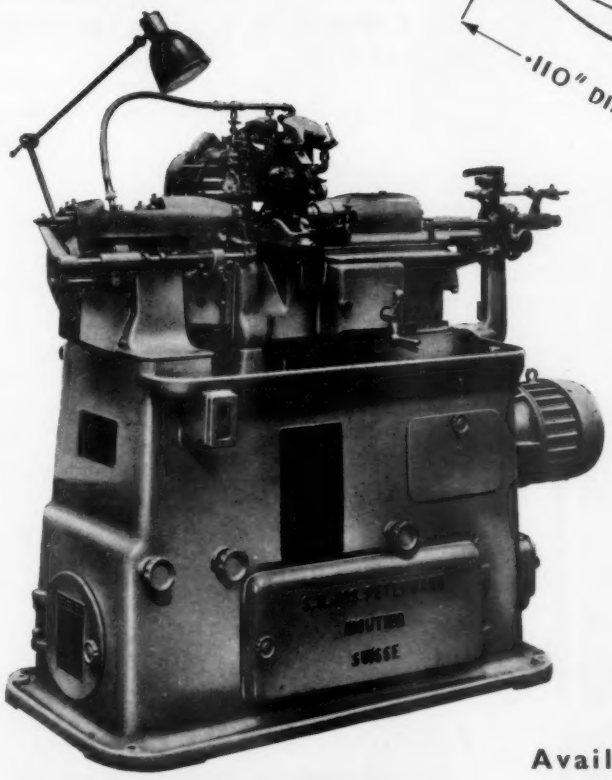
64

per minute on the

PETERMANN P7R

CAPACITY **10** mm.





For the production of parts used for watch, clock, meter and light electrical industries, no machines are more eminent than the Petermann range.

The P7R illustrated has these characteristics:–

5 toolholders with ample clearance.

Screw head slotting attachment when required.

Single camshaft and cam mounting ensuring perfect synchronization of all operations.

Micrometric adjustments for all toolholders so that tools need not be loosened when adjusting.

Automatic stop when bar stock is exhausted **with completion of the last component,** or in the event of defect in drive to the head stock.

Speed range of 2,500 — 10,000 r.p.m. on material of 10 mm. maximum diameter.

Available for immediate delivery.

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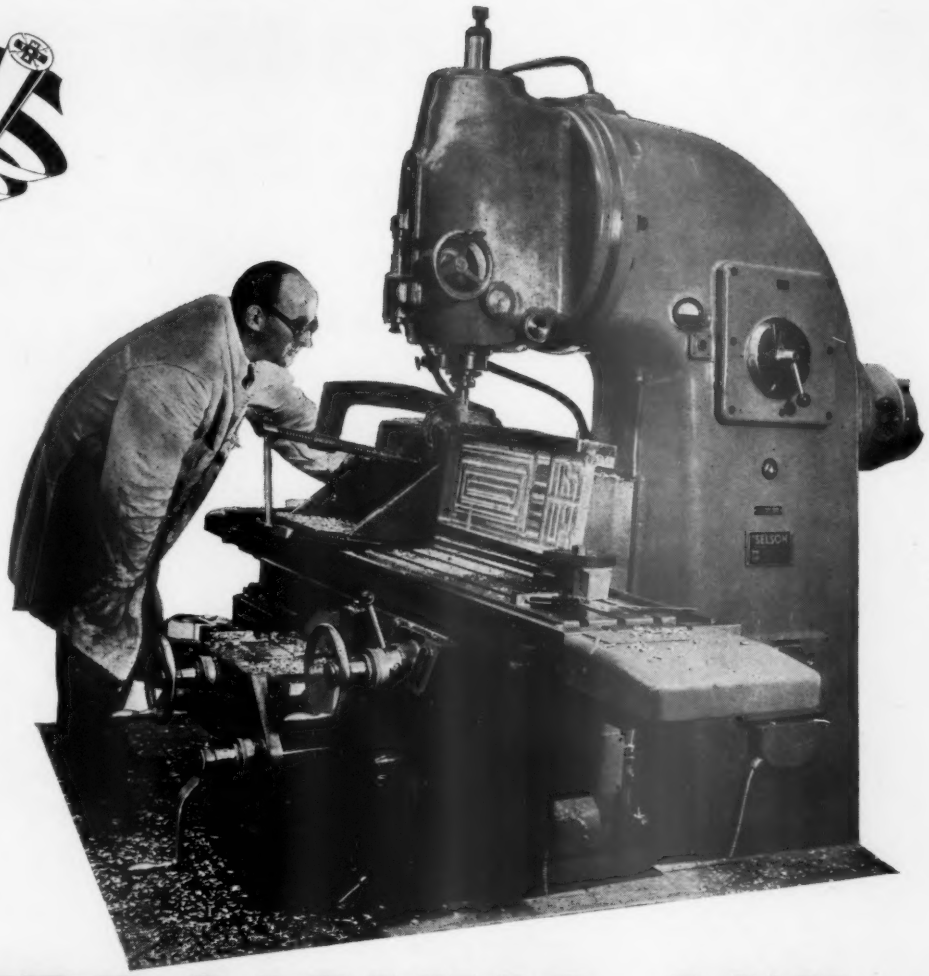

ZBROJOVKA Millers

Complete rigidity at high machining speeds

The illustration shows a Zbrojovka Miller FA5V machining an aircraft main wing spar web from solid billet. It is installed in the Works of Messrs. C. J. C. Developments (Portsmouth) Ltd., Farlington, Portsmouth, by whose courtesy this picture is published.

Brief Specifications of Horizontal, Universal and Vertical Millers

Sizes:	No. 2	No. 3	No. 4	No. 5
Working surface of table (approx.)	40″x 8″	50″x 10″	64″x 12″	80″x 16″
Power longitudinal travel (approx.)	25″	32″	40″	50″
Power cross travel (approx.)	8″	9″	12″	16″
Spindle speeds ...	63-2800	45-2000	32-1400	18-1400

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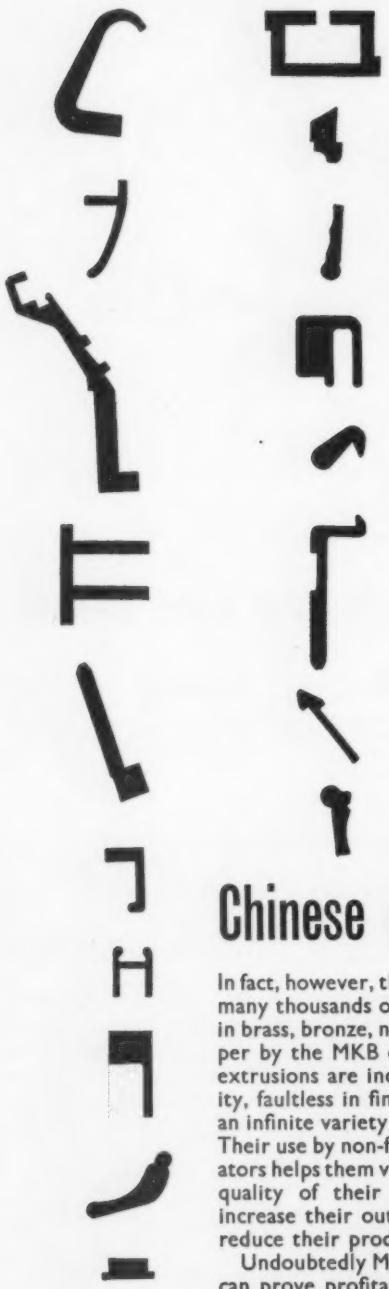
557/SMT 170



Chinese perhaps?

In fact, however, these are some of the many thousands of sections extruded in brass, bronze, nickel silver and copper by the MKB organisation. These extrusions are incomparable in quality, faultless in finish and available in an infinite variety of shapes and sizes. Their use by non-ferrous metal fabricators helps them vastly to improve the quality of their finished products, increase their output and, above all, reduce their production costs.

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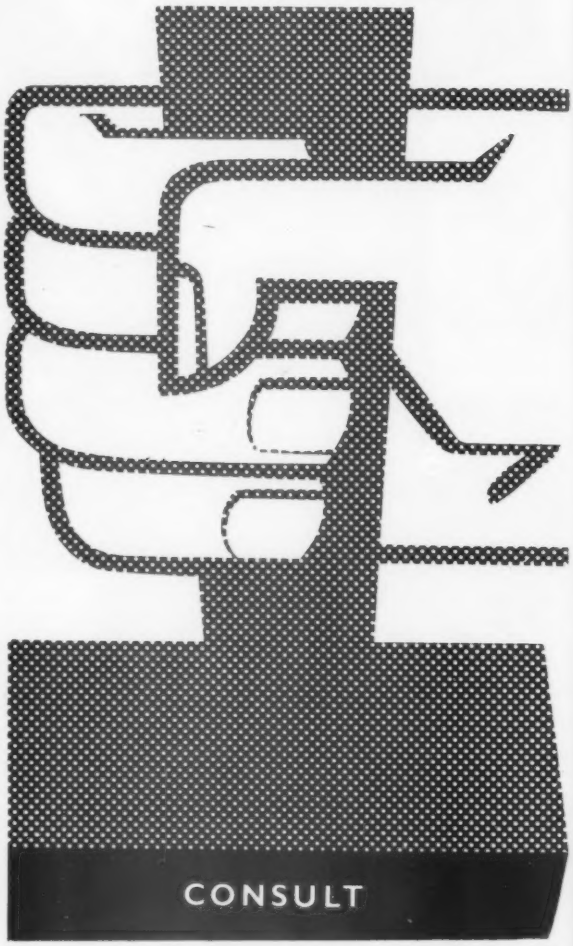

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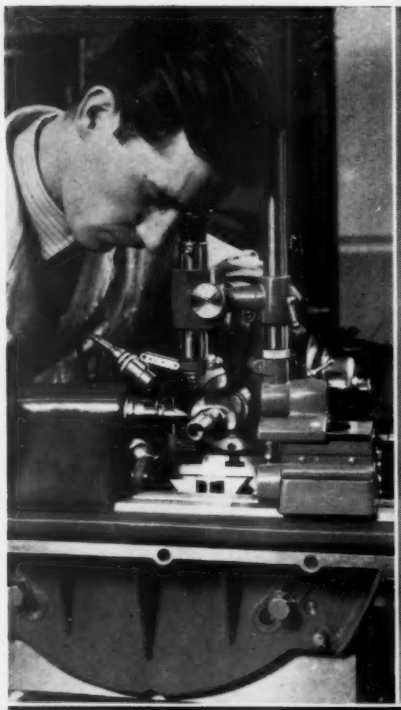

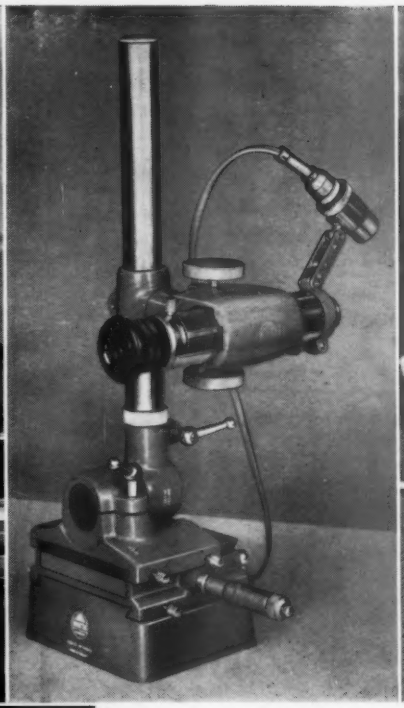

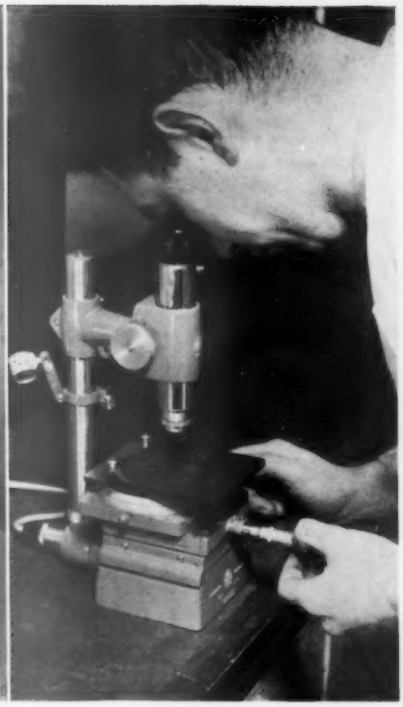

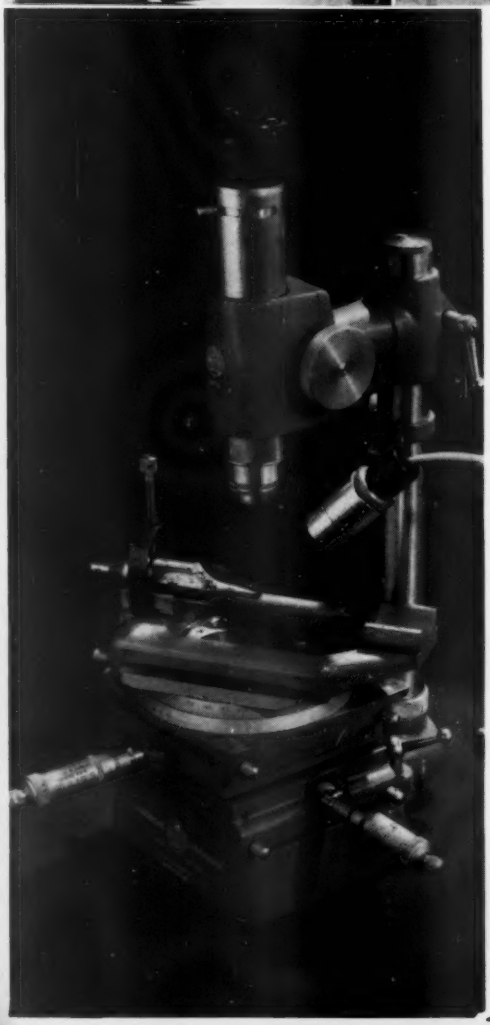

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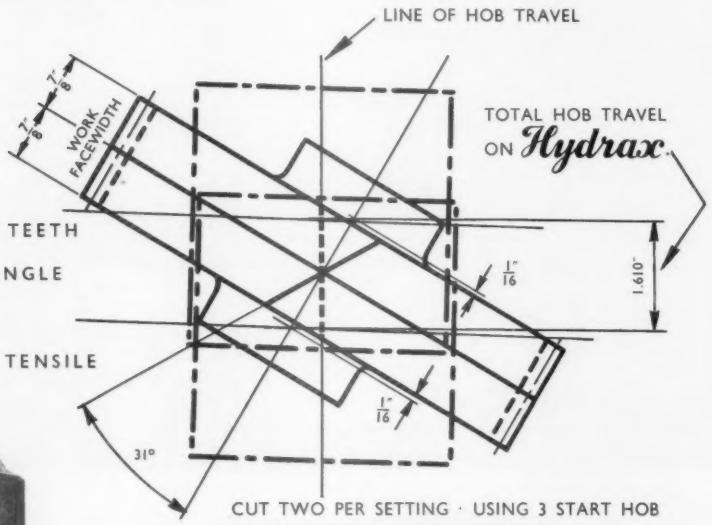
Hydrax production data

TRACTOR MAIN DRIVE TRANSMISSION GEAR



HELICAL GEAR 50 TEETH
8D.P. 31° HELIX ANGLE
7/8" FACE WIDTH
MAT. 45/50 TONS TENSILE

CUT TWO PER SETTING · USING 3 START HOB
FINISH SUITABLE FOR SUBSEQUENT
SHAVING OR GRINDING OPERATION
HYDRAX FLOOR TO FLOOR TIME PER GEAR
80 SECS. · PRODUCTION RATE FOR 8 HOUR
SHIFT AT 80% EFFICIENCY · 288 GEARS

Patent No. 708767
(Foreign Patents pending)

This high rate of production is achieved with higher degrees of accuracy, lower cost per gear and reduced operator fatigue.

Hydrax features include:—

- Hydraulically operated quick acting work clamping.
- Automatic cutting cycle under control of one push button.
- Reduced hob travel for helicals.
- Automatic "Relative" hob shift for helicals.
- Automatic hob shift for spurs.
- No differential or lead cam.

Please write for publication M.104.2.

Hydrax

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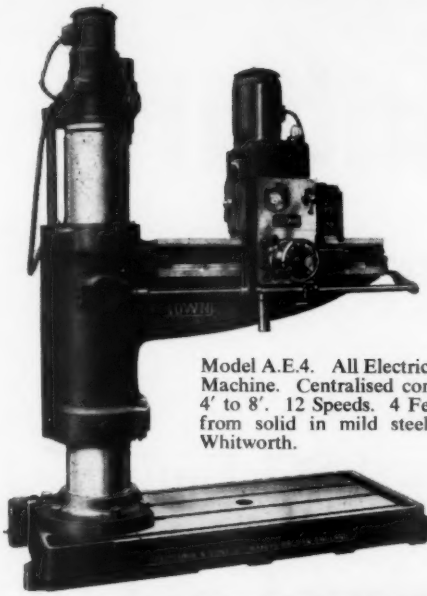
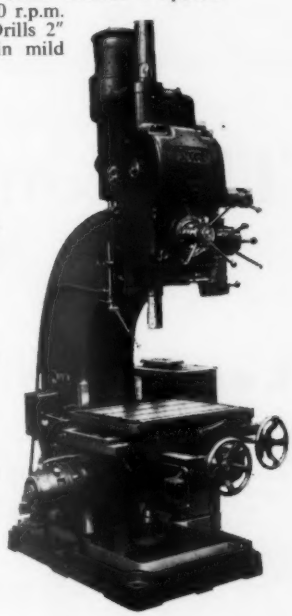
DAVID BROWN
CORPORATION (SALES) LIMITED
MACHINE TOOL DIVISION
BRITANNIA WORKS SHERBORNE STREET
MANCHESTER 3

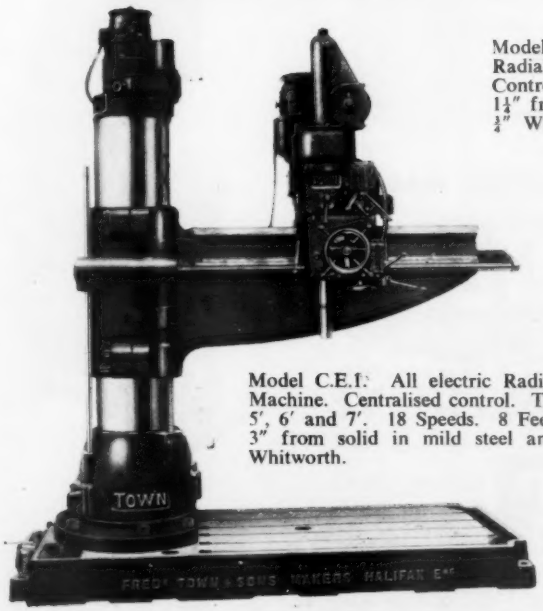


Model A.E.4. All Electric Radial Drilling Machine. Centralised control. Six sizes, 4′ to 8′. 12 Speeds. 4 Feeds. Drills 2⅛″ from solid in mild steel and taps 1¼″ Whitworth.

Models E.G.4 and E.G.8. All Electric Girder Type Radial Drilling Machines. Centralised control. Each model made in five sizes from 4′ to 8′ E.G.4: 4 Speeds. 4 Feeds. E.G.8: 8 Speeds. Range 20-500 r.p.m. 4 Speeds. Drills 2″ from solid in mild steel.

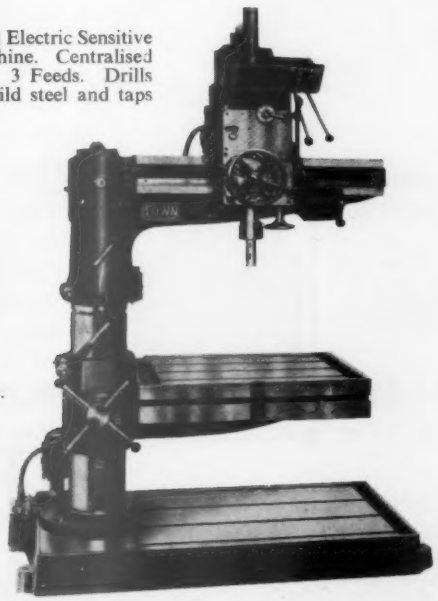


Model A.E.2. All Electric Heavy Duty Vertical Drilling Machine. Centralised control. Two sizes: 36″ and 42″. 18 Speeds. 8 Feeds. Drills 3½″ from solid in mild steel.



Model C.E.I. All electric Radial Drilling Machine. Centralised control. Three sizes: 5′, 6′ and 7′. 18 Speeds. 8 Feeds. Drills 3″ from solid in mild steel and taps 2″ Whitworth.

Model A.E.5. 42″ All Electric Sensitive Radial Drilling Machine. Centralised Control. 9 Speeds. 3 Feeds. Drills 1½″ from solid in mild steel and taps ¾″ Whitworth.



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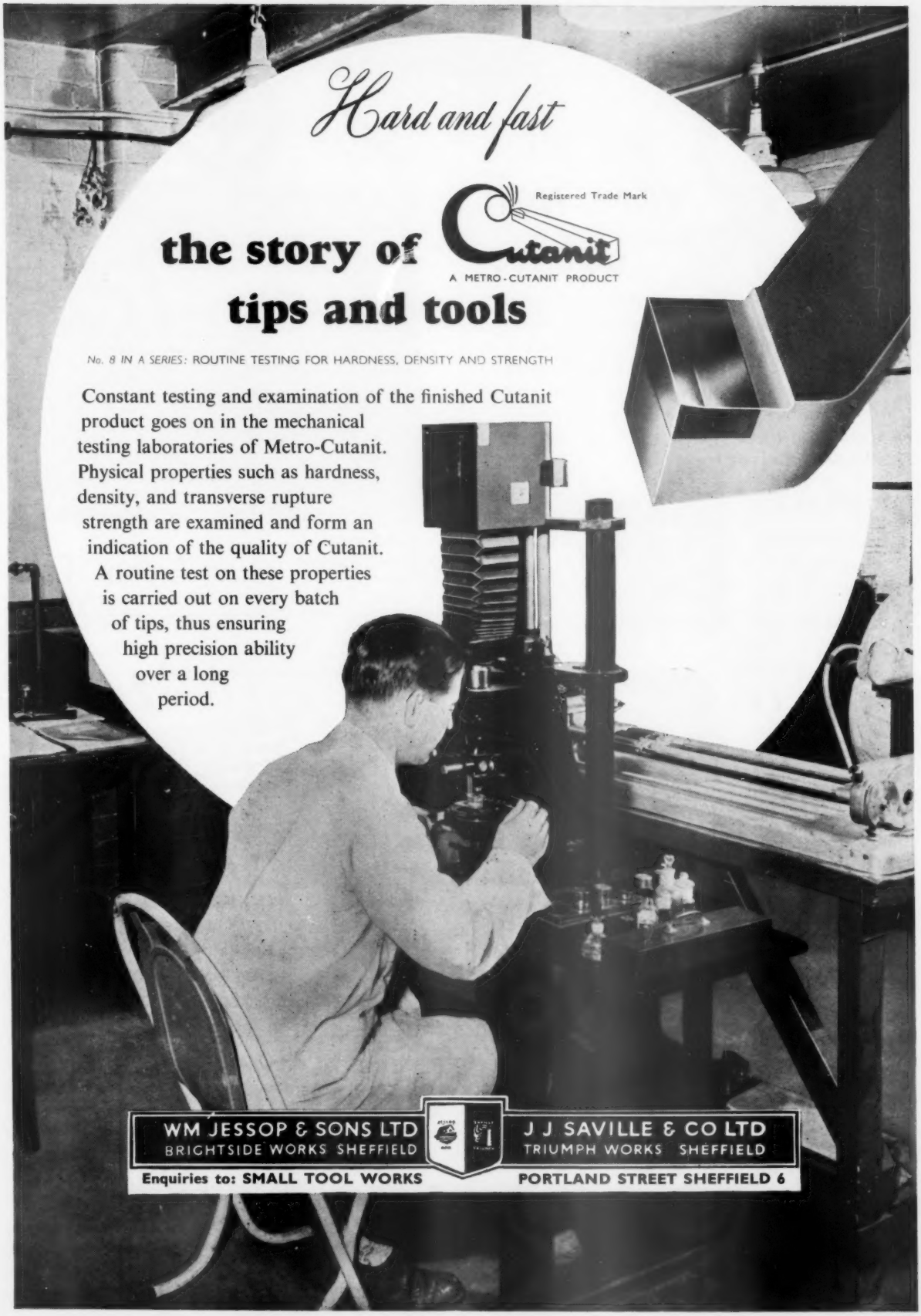
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INDEX TO ADVERTISEMENTS

	Page
Accles & Pollock, Ltd.	xlii
Adcock & Shipley, Ltd.	v
Allen, Edgar & Co. Ltd.	lxxxix
Alumilite & Alzak, Ltd.	—
Archdale, James & Co. Ltd.	liii
Armstrong Patents Co. Ltd.	lxxx
Arrow Electric Switches, Ltd.	—
Asquith, William, Ltd.	xxviii
Automatic Coil Winder & Electrical Equipment Co. Ltd., The	iv
Barber & Colman, Ltd.	—
Bawn, W. B. & Co. Ltd.	xx
Bedford, John, & Sons, Ltd.	lxxv
Benton & Stone, Ltd.	—
B.I.P. Chemicals, Ltd.	—
Birlec, Ltd.	vi
Birmingham Aluminium Casting (1903) Co. Ltd.	iii
Black & Decker, Ltd.	xxv
Bratby & Hinchliffe, Ltd.	lxviii
Bray Accessories, Ltd.	lxxxviii
British Aero Components, Ltd.	—
British Die Casting & Engineering Co. Ltd.	lviii
British Electrical Development Association, The	lxxi
British Tabulating Machine Co. Ltd.	—
British Thomson-Houston Co. Ltd.	—
Broadbent, Henry, Ltd.	—
Brockhouse, J. & Co. Ltd.	lxxiv
Brookhirst Switchgear, Ltd.	—
Broom & Wade, Ltd.	—
Brown, David, Corporation (Sales) Ltd., The	lxxxvii
B.S.A. Tools, Ltd.	—
Burton Griffiths & Co. Ltd.	xxii
Butler Machine Tool Co. Ltd., The	—
Butterley Co. Ltd., The	xl
Catmur Machine Tool Corporation, Ltd.	—
Churchill, Charles & Co. Ltd.	lxxiii
Churchill Machine Tool Co. Ltd.	xxxiii
Cincinnati Milling Machines, Ltd.	—
Climax Rock Drill & Eng. Works Ltd.	—
Cohen, George, Sons & Co. Ltd.	—
Concentric Manufacturing Co. Ltd.	lv
Cossor, A. C., Ltd.	—
Coventry Climax Engines, Ltd.	*Outside Back Cover*
Coventry Gauge & Tool Co. Ltd.	—
Cow, P. B., Ltd.	—
Croda, Ltd.	xc
Crofts (Engineers), Ltd.	li
Crompton Parkinson, Ltd.	—
Dawe Instruments, Ltd.	xxxi
Dawson Bros., Ltd.	lxx
Dean Smith & Grace, Ltd.	xviii
Dowding & Doll, Ltd.	xxxix
Drummond Asquith (Sales), Ltd.	xxx
Drummond Bros., Ltd.	xxix
Durachrome, Ltd.	lxvi
Dyson & Co. Enfield (1919), Ltd.	—
Edibrac, Ltd.	lxvi
Electro-Chemical Eng. Co. Ltd.	—
Electro-Dynamic Construction Co. Ltd.	lxxxi
Elgar Machine Tool Co. Ltd.	lvii
Elliott Brothers (London) Ltd.	—
E.M.S. Electrical Products, Ltd.	xciv
English Electric Co. Ltd., The	xvii
Exors of James Mills, Ltd.	xiv
Fawcett-Finney, Ltd.	xxxvii
Fescol, Ltd.	xx
Financial Times	xiii
Firth Brown Tools, Ltd.	viii
Firth, Thos., & Brown, John, Ltd.	—
Flame Hardeners, Ltd.	—
Fletcher Miller, Ltd.	—
Fox Chemical Engineering Works, Ltd.	—
Fox, Samuel & Co. Ltd.	xxiii
Fraser, Andrew & Co. Ltd.	—
Gledhill-Brook Time Recorders, Ltd.	lxxiv
Glostics, Ltd.	lvi
G.P.A. Tools & Gauges, Ltd.	lxii
Guest, Keen & Nettlefolds (Midlands), Ltd.	—
Guylee, Frank, & Son, Ltd.	lxxxii
Harrison, T. S. & Sons, Ltd.	—
Harris Tools, John, Ltd.	—
Heenan & Froude, Ltd.	xliii
Herbert, Alfred, Ltd.	xxxv
Hilger & Watts, Ltd.	lxxxv
Holman Bros., Ltd.	xix
Hoover, Ltd.	—
Hordern, Mason & Edwards, Ltd.	—
Horstmann Gear Co. Ltd., The	lxxxii
Howard, Stanley, Ltd.	xii
Hymatic Engineering Co. Ltd., The	—
Igranic Electric Co. Ltd.	lxiii
Imperial Smelting Corporation (Sales), Ltd.	xxvii
Impregnated Diamond Products, Ltd.	xlviii
Integra, Leeds & Northrup, Ltd.	—
Intermit, Ltd.	lxxxvi
Jessop, Wm. & Sons, Ltd.	xcv
Johansson, C. E., Ltd.	xlv
Jones, E. H. (Machine Tools), Ltd.	lxi
Jones, Sidney G., Ltd.	xlix
King, Geo. W., Ltd.	lxxxiii
Kirkstall Forge Engineering, Ltd.	liv
Lang, John & Sons, Ltd.	xxxii
Lang Pneumatic, Ltd.	xlvii
Lansing Bagnall, Ltd.	—
Lapointe Machine Tool Co. Ltd., The	—
Levy, D. E. & J.	xcvii
Ley's Malleable Castings Co. Ltd.	xv
Lloyd, F. H. & Co. Ltd.	—
Lloyd, Richard, Ltd.	xc
London Oil Refining Co. Ltd., The	xcii
Lund, John, Ltd.	xxxvi
Machine Shop Equipment, Ltd.	—
Machinery Publishing Co. Ltd.	—
Magnesium Elektron, Ltd.	—
Manganese Bronze & Brass Co. Ltd.	—
Marbaix, Gaston E., Ltd.	—
Markland Scowcroft, Ltd.	—
Marsh, Bros., & Co. Ltd.	lxxii
Marshall-Richards Machine Co. Ltd.	—
McKechnie Bros., Ltd.	lxxxiv
Metal Industries Group	xxxvii, lxiii, lxv
Metropolitan-Vickers Electrical Co. Ltd.	—
Midland Iron Co. Ltd., The	—
Mollart Engineering Co. Ltd., The	—
Monks & Crane, Ltd.	vii
Morris, B. O., Ltd.	—
Myford Engineering Co. Ltd.	—
National Industrial Fuel Efficiency Service	xcvii
Neill, James, & Co. (Sheffield), Ltd.	lxxviii
Newall, A. P. & Co. Ltd.	lxxvi
Newall Group Sales, Ltd.	lxvii, lxxvii
Newall Group Sales, (Tolimit Gauges), Ltd.	—
Park Gate Iron & Steel Co. Ltd.	*Inside Back Cover*
Parkinson, J., & Son (Shipley), Ltd.	—
Paterson Hughes Engineering Co. Ltd.	xliv
Pilot Works, Ltd.	xcii
Pollard Bearings, Ltd.	—
Precision Grinding, Ltd.	lx
Press Equipment, Ltd.	—
Proctor Bros. (Wireworks), Ltd.	lxxii
Pryor, Edward, & Son, Ltd.	—
Quasi Arc, Ltd.	xxi
Rack Engineering, Ltd.	x
Radio Heaters, Ltd.	—
Ransomes, Sims & Jefferies, Ltd.	—
Ratcliffe, F. S., (Rochdale), Ltd.	xcvi
Reavell & Co. Ltd.	lxxvi
Redfern's Rubber Works, Ltd.	—
Rediffusion, Ltd.	lxxviii
Reliance Gear & Eng. Co. (Salford), Ltd.	—
Rockwell Machine Tool Co. Ltd., The	xxiv
Russell, S. & Sons, Ltd.	—
Ryder, Thos. & Son, Ltd.	lxix
Saville, J. J. & Co. Ltd.	xcv
Scrivener, Arthur, Ltd.	lix
Selson Machine Tool Co. Ltd., The	lxxix
Sentinel (Shrewsbury), Ltd.	lxv
Service Electric Co. Ltd.	xciv
Shell-Mex & B.P., Ltd.	xi
Skinners, (Redbridge), Ltd.	—
Smart & Brown Machine Tools, Ltd.	lxxxviii
Snow & Co. Ltd.	xxxviii
Sparcatron	lxiv
Sparklets, Ltd.	lxxxiv
Spencer & Halstead, Ltd.	—
Sternol, Ltd.	lxxx
Sunbeam Anti-Corrosives, Ltd.	xli
Swales, C. A., (Filters), Ltd.	—
Swift-Summerskill, Ltd.	lxviii
Sykes, W. E., Ltd.	—
Teleflex Products, Ltd.	lxx
Town, Frederick & Sons, Ltd.	xci
Turner Machine Tools, Ltd.	—
Udal, J. P., Ltd.	xcvi
Unbrako Socket Screw Co. Ltd.	lii
United Steel Companies, Ltd., The	xxiii
Universal Tools, Ltd.	—
Van Moppes & Sons (Diamond Tools), Ltd.	—
Vulcascot (Great Britain), Ltd.	xcvi
Wadkin, Ltd.	lxxvi
Ward, H. W., & Co. Ltd.	xxxiv
Ward, Thos. W., Ltd.	—
Weatherall Green & Smith	xcvii
Webster & Bennett, Ltd.	ix
Westool, Ltd.	xciii
Whyte & Collins, Ltd.	—
Wickman, Ltd.	xxvi
Wicksteed, Chas. & Co. (1920), Ltd.	—
Woodhouse & Mitchell	l
Wolverhampton Die Casting Co. Ltd., The	xlvi
Yale & Towne Manufacturing Co., The	xvi
Zinc Alloy Die Casters Association	—
Zwicky, G. (London), Ltd.	—

All communications regarding advertisements should be addressed to the Advertising Managers, T. G. Scott & Son, Ltd.
Crown House, 143-147, Regent Street, London, W.1. Phone: Regent 3891.
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al
Page
Cover
xliv
xcii
lx
lxxii
xxi
x
xcvi
lxxvi
xxviii
xxiv
lxix
xcv
lix
lxxix
lxv
xciv
xi
xxviii
xxviii
lxiv
xxxiv
lxxx
xli
lxviii
lxx
xci
xcvi
lii
xxiii
xcvi
lxxvi
xxxiv
xcvii
lx
xciii
xxvi
l
xlvi
xvi

PARK GATE

QUALITY STEELS FOR RAPID MACHINING

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special
freecutting
quality bars

THE PARK GATE IRON & STEEL CO. LTD., ROTHERHAM

TELEPHONE : ROTHERHAM 2141 (10 lines) TELEGRAMS : YORKSHIRE, PARKGATE, YORKS

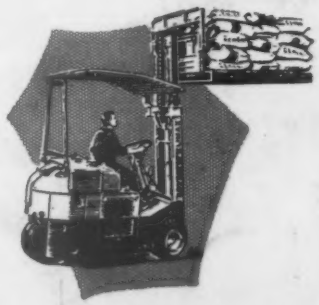
"... in one of our new depots it now takes only 0·44 man/hours for each ton moved, whereas under the old system it took 1·22 man/hours....

Lord Heyworth Chairman UNILEVER LTD.

.... Handling methods have been revolutionised by the fork lift truck and the pallet. This method has the advantage of moving and storing goods in unit-loads of a pre-determined number of standard packages to each pallet. It enables them to be stacked much higher without damage, and to be moved more easily both vertically and horizontally. It simplifies the administrative work in store-keeping and it greatly speeds up the turn-round of transport vehicles, both rail and road...."

FORK LIFT TRUCKS are made by

Coventry Climax



COVENTRY CLIMAX ENGINES LIMITED (DEPT JIP) COVENTRY, ENGLAND

JOURNAL SUPPLEMENT

Vol. 34, No. 12
DECEMBER, 1955

INSTITUTION OF PRODUCTION ENGINEERS, 10, CHESTERFIELD ST., LONDON, W.1

FOURTH CONFERENCE ON

Problems of Aircraft Production

(promoted by the Southern Section of the Institution)

UNIVERSITY OF SOUTHAMPTON

(by kind permission of the Vice-Chancellor)

6th and 7th January, 1956

The theme of the Fourth Conference is :

" Speeding Aircraft Production "

A special feature of the Conference will be the inauguration of the Lord Sempill Paper, which will be presented by Sir Roy Fedden, M.B.E. Other Papers presented will deal with the most recent developments in production technique, machine tools, and production processes. Full details of the programme will be available shortly.

The Conference fees, inclusive of luncheon on the first day, and light refreshments, are:

Members of the Institution and Affiliate Representatives	**35/-**
Non-members	**45/-**

A form of application for tickets appears overleaf. As accommodation at the University is limited, tickets will be distributed in strict order of application.

ANNUAL GENERAL MEETING - PRELIMINARY NOTICE

The Annual General Meeting of the Institution will be held at 10, Chesterfield Street, London, W.1, at 2 p.m., on Thursday, 26th January, 1956.

Date rec'd at Head Office

To: The Secretary,
Institution of Production Engineers,
10 Chesterfield Street,
London, W.1.

FOURTH AIRCRAFT PRODUCTION CONFERENCE

1. *NAME* .....
2. *Grade of Membership* .....
2a. *Honours, degrees, other quals.* .....
3. *ADDRESS* .....
4. *NAME OF COMPANY* .....
5. *POSITION HELD* .....

N.B.—If more than **ONE** ticket is required, please supply information 1 to 5 on a separate sheet of paper for each ticket applied for.

Please send me.....member's tickets at 35/- each. for which I enclose my remittance for £.....

Please send me.....non-member's tickets at 45/- each.

Signature.....

Date.....

Note.—Cheques, etc., should be made payable to: " **The Institution of Production Engineers.**"

THE 1955 SIR ALFRED HERBERT PAPER

This Paper will be presented at the Royal Institution, Albemarle Street, London, W.1, on 9th February, 1956, at 6.30 p.m. when Dr. N. H. MACKWORTH, Head of the Applied Psychology Research Unit of the Medical Research Council, will speak on:

" Equipment and Training for Skilled Work "

A form of application for tickets of admission to the meeting will appear in the January issue of the Supplement.

INSTITUTION PUBLICATIONS

The following Institution Publications are available and may be ordered by completing the forms overleaf :

"*The Automatic Factory — What Does It Mean* ?"—The full Report of the Margate Conference. This publication has been very favourably reviewed and the demand for it is such that a second print is being contemplated. Unfortunately, owing to increased costs, the price of the second edition will have to be increased, but a number of copies still remain available at 25/- each, post free.

Material Utilisation in the Metal-working Industries—Report of the Sub-Committee of the Institution's Research Committee. Price 5/- per copy, post free.

Production Control and Related Works Statistics—Report of the Joint Committee of the Institution of Production Engineers and the Institute of Cost and Works Accountants. Price 5/- per copy, post free.

GRADUATES CONFERENCE, 1956

The Liverpool Graduate Section Committee are planning to organise a Conference for graduates and students of the Institution to be held in Liverpool in the Spring of next year. The subject to be discussed will be technical education and training.

Full details will be published in due course.

"THE AUTOMATIC FACTORY — WHAT DOES IT MEAN?"

To: The Secretary,
Institution of Production Engineers,
10 Chesterfield Street,
London, W.1.

Please send me.....copy/ies of the bound publication of the Proceedings of the Margate Conference at 25/- each, post free. I enclose £.....in payment.

ADDRESS.....

Block letters *NAME*.....

PLEASE .....

.....

All remittances should be made payable to "The Institution of Production Engineers"

To: The Secretary,
Institution of Production Engineers,
10 Chesterfield Street,
London, W.1.

REPORT ON "MATERIAL UTILISATION"

Please send me.....copy/ies of the above Report, at five shillings each, post free. I enclose remittance for £.....made payable to "The Institution of Production Engineers".

NAME.....

Block letters *ADDRESS*.....

PLEASE .....

.....

To: Gee & Co. (Publishers) Ltd.,
27/28 Basinghall Street,
London, E.C.2.

REPORT ON "PRODUCTION CONTROL AND RELATED WORKS STATISTICS"

Please send me.....copy/ies of the above Report, at 5/- each, post free when available. I enclose remittance for £..... made payable to Gee & Co. (Publishers) Ltd.

NAME.....

Block letters *ADDRESS*.....

PLEASE .....

.....

"So You're Going To A Meeting" by Sir Walter Puckey.—An invaluable handbook for anyone concerned with or serving on Committees of any kind. Although written with a light touch, the book is full of useful comment, derived from the author's life-time experience of this activity.

The price of 5/- plus 4d. postage, is little more than the cost of publication and distribution, but Sir Walter has kindly agreed that any profits that might accrue from the sale of this book will be donated to the Institution.

REGIONAL MEETINGS

SOUTH WESTERN REGION — **7.15 p.m. December 7th**

"Aircraft Design for Production"

by W. E. W. PETTER, C.B.E., B.A., F.R.Ae.S.,
at The Large Lecture Theatre, Bristol University Engineering Laboratories, University Walk, Bristol, 8. (Joint meeting with the Bristol Branch of the Royal Aeronautical Society).

MIDLANDS REGION — **7.0 p.m. December 14th**

"The Implications of Automation"

by FRANK G. WOOLLARD, M.B.E., M.I.Mech.E., M.I.Prod.E., M.I.I.A., M.S.A.E. in the Main Hall of the Wolverhampton & Staffordshire Technical College, Wolverhampton.

SECTION MEETINGS

Visitors' tickets may be obtained from Section Honorary Secretaries.

DECEMBER, 1955

EAST & WEST RIDINGS REGION

Doncaster — **7 p.m. December 13th**
The Danum Hotel, Doncaster.
"Safety in Industry" by J. L. Hobson, B.Sc.

Halifax — **7.15 p.m. December 12th**
The George Hotel, Huddersfield.
"New Methods of Measuring Productivity with Particular Reference to the Welding Industry" by A. G. Thompson.

Halifax Graduate — **7.30 p.m. December 7th**
The White Swan Hotel, Halifax.
"Public Speaking" by W. F. S. Woodford (Secretary of the Institution).

Halifax Graduate — **December 14th**
Works visit to the Fountain Glass Works, Roberttown.

Sheffield — **6.30 p.m. December 12th**
The Grand Hotel, Sheffield.
"Fabrication for Heavy Engineering" by J. A. M. Stirling and R. Bagshaw. (Joint meeting with the Institute of Welding).

Yorkshire — **7 p.m. December 12th**
The Hotel Metropole, King Street, Leeds, 1.
"Automatic Linking Devices" by J. A. Hunt, M.B.E., M.I.I.A. and J. B. Jay, A.M.I.Mech.E.

EASTERN REGION

Eastern Counties — **7.30 p.m. December 9th**
Diocesan Hall, Tower Street, Ipswich.
"Developments in the Manufacture and Packaging of Granular Compound Fertiliser" by A. T. Brook, D.I.C., M.Sc., A.M.I.Mech.E.

MIDLANDS REGION

Birmingham — **7 p.m. December 10th**
Botanical Gardens, Birmingham.
Christmas Party.

Birmingham Graduate — **7 p.m. December 13th**
The James Watt Memorial Institute, Gt. Charles Street, Birmingham.
Film of World Tour by S. J. Harley, B.Sc., M.I.Mech.E., M.I.Prod.E.

Coventry — **7 p.m. December 7th**
The Craven Arms, High Street, Coventry.
"Shipbuilding and Naval Architecture" by J. Brown (Director and Chief Naval Architect, John Brown & Co. Ltd., Engineers and Shipbuilders, Clydebank).

Wolverhampton Graduate — **9.30 a.m. December 3rd**
Works visit to G.E.C., Birmingham.

To: The Secretary,
Institution of Production Engineers,
10 Chesterfield Street,
London, W.1.

"SO YOU'RE GOING TO A MEETING"

Please send me.....copy/ies of the above book, at 5/4d, including postage. I enclose remittance for £.....made payable to "The Institution of Production Engineers".

ADDRESS.....

Block letters *NAME*.....

PLEASE .....

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Wolverhampton Graduate
7 p.m. for 7.30 p.m. December 23rd
The Mount Hotel, Tettenhall Wood.
Dinner Dance.

NORTH MIDLANDS

Derby **7 p.m. December 19th**
The College of Art, Derby.
"Fundamentals of Progressive Tooling" by J. A. Grainger, A.M.I.Mech.E., A.M.I.Prod.E., A.M.I.I.A.

Lincoln **7.30 p.m. December 15th**
Ruston Club, Unity Square, Lincoln.
Film Show.

Nottingham **7 p.m. December 7th**
The Victoria Station Hotel, Nottingham.
"Colour as an Aid to Production" by Miss P. Raine.

Peterborough **7.30 p.m. December 6th**
The White Lion Hotel, Church Street (opposite Corn Exchange), Peterborough.
"The Use of Plastics in Engineering" by B. E. Terry, A.M.I.Prod.E.

Peterborough **10.30 p.m. December 11th**
Works visit to The British Sugar Corporation Ltd., Peterborough.

NORTHERN REGION

North Eastern **7 p.m. December 19th**
Neville Hall, Newcastle-upon-Tyne.
Film Evening. Ladies are invited to this meeting.

NORTHERN IRELAND REGION

Northern Ireland **7.30 p.m. December 1st**
Kensington Hotel, College Square East, Belfast.
"Cutting Tools and Lathe Development" by K. W. Metcalfe.

NORTH WESTERN REGION

Liverpool **7.30 p.m. December 7th**
Picton Hall, Liverpool.
"History of Engineering". (In conjunction with City of Liverpool Public Libraries.)

Manchester Graduate **6.55 p.m. December 13th**
Visit to the School of Signalling, British Railways, Manchester Victoria Station, Manchester, in the form of a short lecture of approx. 1 hour, followed by a demonstration of equipment on the model electric railway. Intending visitors should await circularisation by Visits Secretary.

Preston **7.15 p.m. December 14th**
The College of Further Education, Accrington.
"Reading Technique" by H. Bayley, B.A., M.Ed.

SCOTTISH REGION

Dundee **7.30 p.m. December 14th**
New Imperial Hotel, 15, Tally Street, Dundee.
"New Methods of Measuring Productivity with Particular Reference to the Welding Industry" by A. G. Thompson.

Glasgow **7.30 p.m. December 17th**
The Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow, C.2.
"The Varied Application of Drilling Machines in Relation to Production" by W. A. Hannaby, M.I.Prod.E.

SOUTHERN REGION

Oxford **7.15 p.m. December 13th**
Town Hall, Oxford.
"Technical Training for Automation" by S. A. J. Parsons, M.I.Prod.E.

Reading **7.30 p.m. December 1st**
The Great Western Hotel, Reading.
"Budgetary Control and Standard Costs" by R. Cutler, M.C.I.A.

Southern **7.15 p.m. December 15th**
The Polygon Hotel, Southampton.
"Production Methods in Railway Workshops" by T. B. Maddison, A.M.I.Prod.E.

SOUTH EASTERN REGION

London **7 p.m. December 8th**
The Royal Empire Society, Northumberland Avenue (Craven Street Entrance), Strand, London, W.C.2.
Symposium "Unusual Aspects of Modern Press Work".
1. "Heavy Press Work in the Automobile Industry" by K. Winslow, A.M.I.Mech.E.
2. "Unconventional Tooling" by S. E. Kirk, M.B.E., M.I.Prod.E.
3. "Spark Machining of Dies" by E. Foster, A.M.I.Elec.E.

London Graduate **7.15 p.m. December 14th**
10 Chesterfield Street, London, W.1.
"The Selection, Care and Use of Industrial Diamonds" by R. A. Straker-Nesbit.

Luton Graduate **2 p.m. December 10th**
Works visit to N.P.L., Teddington.

Rochester **7.30 p.m. December 8th**
Assembly Room, Sun Hotel, Chatham.
"Lock Design and Manufacture" by C. G. Smith, A.M.I.Prod.E.

SOUTH WESTERN REGION

Gloucester **7.30 p.m. December 1st**
Belle Vue Hotel, Cheltenham.
"Induction Heating and its Application" by D. Jones, B.Sc.(Hons.).

Gloucester **December 3rd**
Works visit to Messrs. Delapena & Son Ltd., Zona Works, Cheltenham.
Applications must be made to Section Secretary for this visit.

WELSH REGION

West Wales **7.30 p.m. December 9th**
Central Library, Alexandra Road, Swansea.
"Modern Production and Its Influence on Costs" by J. P. Wilson.

JANUARY, 1st-7th, 1956

MIDLANDS REGION

Wolverhampton **7.15 p.m. January 4th**
The Wolverhampton and Staffs. Technical College, Wolverhampton.
"Forgings and Pressings in High Strength Aluminium Alloys" by J. E. Earl, A.M.I.Prod.E.

NORTH MIDLANDS REGION

Nottingham **7 p.m. January 4th**
The Victoria Station Hotel, Nottingham.
Informal Discussion.

NORTH WESTERN REGION

Liverpool Graduate **7.30 p.m. January 3rd**
The Stork Hotel, Queens Square, Liverpool.
Details to be announced later.

Liverpool Graduate **January 7th**
Works visit to Messrs. I.C.I. Ltd., Metals Division, Kirkby Works, East Lancashire Road, Liverpool.

SOUTHERN REGION

Oxford **7.15 p.m. January 3rd**
The Town Hall, Oxford.
"Cost Accounting as an Aid to Efficient Production" by H. J. Furness, F.C.W.A. Meeting arranged in conjunction with the Oxfordshire Sub-Branch of the Institute of Cost and Works Accountants.

Southern **7.30 p.m. January 5th**
The Southampton University.
"Economic and Social Effects of Automation" by R. R. Williams. Members of the Southern Section will be guests of the Institute of Plastics.

PRODUCTION APPOINTMENTS

BULLETIN No. 27
DECEMBER 1955

The last date for receiving material for insertion in the following month's bulletin is the 20th of each month.
The fee for insertion of particulars regarding each appointment is £3 3s. (up to 100 words), and over 100 words £5 5s. A standard charge of £1 1s. per insertion is made to firms affiliated to the Institution, Technical Colleges, Universities and similar organisations.
Advertisers are advised that better response is likely if, in addition to essential qualifications, the following information is given:—

(*a*) Location of appointment; (*b*) Status in the organisation and scope of promotion; (*c*) Salary range and age range. Advertisers are asked to advise the Institution when appointments are filled. The Institution reserves the right to refuse or withdraw any announcement and also to make any alteration in the wording to ensure conformity with the Institution standards. *Members interested in the following appointments should make application in accordance with the terms of notice. No correspondence can be undertaken by the Secretary other than the forwarding of replies to Box Nos.*

All advertisements appearing in this Bulletin are subject to the Notification of Vacancies Order of 1952.

Planning Engineer required for production office of company engaged in the manufacture of ordnance equipment. Workshop training, tool design and process planning experience essential. Staff position with good salary and prospects. Apply to: The Personnel Manager, John Thompson Limited, Ettingshall, Wolverhampton.

Tool Designer/Draughtsman. Experienced in injection and compression moulds. Pleasant working conditions, pension fund, permanency for the right man. Salary commensurate with experience and ability. Prepared to reside in Lincolnshire. Apply: Managing Director, Godfrey Holmes (Plastics) Limited, Wragby, Lincolnshire.

Works Manager required by light engineering works in Sussex, manufacturing own specialised products. Small but expanding company presenting good opportunity to capable man. Write stating age, full details of past experience, present salary and salary required to: Box No. 1232, I.Prod.E., 10 Chesterfield Street, London, W.1.

Senior Methods Engineers, Planning & Estimating Engineers. The English Electric Co. Ltd., Stevenage, Herts, invite applications for the following positions: **Senior Methods Engineers.** Applications for these positions are invited from Senior Methods Engineers who are fully experienced in one of the following types of work as applied to prototype or medium quantity production: (a) Manufacture of structures (airframe); (b) manufacture of instruments; (c) manufacture of electronic equipment. These senior appointments bear the responsibility for reviewing designs for ease of manufacture, forward planning and investigation of methods of production. **Planning & Estimating Engineers.** A number of vacancies exist in the production engineering department for Planning and Estimating Engineers with experience in light-medium engineering. Applicants should have served a full apprenticeship and should preferably possess H.N.C. or its equivalent. These positions carry attractive salaries with excellent prospects for those showing initiative. A pension scheme is available after a qualifying period, and housing assistance can be given in most cases. Replies should be addressed to: Dept. C.P.S., 336/7 Strand, London, W.C.2, quoting Ref. No. 1343J.

A Graduate Engineer is required by a progressive British Company as Technical Assistant to the Chief Engineer of one of its modern processing factories. Many problems of a technical nature arise, and the successful applicant will take responsibility for handling these. The responsibility is clearly defined and initial training over many months will be given to prepare the new man for the position. A good degree in mechanical engineering and some basic workshop training is necessary. The Company is prepared to delay the appointment should the right applicant not be immediately available. Age limit 28 years. This position is a starting point in the organisation and an excellent commencing salary will be paid to which will be added substantial increments in line with his progress and development. In judging applicants the Company will be looking at the man's development possibilities, both technical and administrative, as the Company has a long record of healthy growth and wants its new men to be capable of growing with it. All factors such as superannuation scheme, etc., are available to suitable candidates who should send, in confidence, a brief outline of their career to date, Box No. 1233, I.Prod.E., 10 Chesterfield Street, London, W.1.

Engineer with good degree or equivalent qualification required for investigation of automation techniques and new engineering production processes. Work may include visits to engineering firms throughout the country. For an engineer with initiative and personality there is considerable scope for advancement. The position is superannuated and carries a good commencing salary. Send full details, including age, qualifications, experience and present salary in confidence to: Box No. 1244, I.Prod.E., 10 Chesterfield Street, London, W.1.

A Graduate is required for basic and applied research on the machining and cold forming of metals. A good degree (or equivalent qualification) in engineering, metallurgy or physics is required. There are good prospects for advancement. Commencing salary commensurate with qualifications and experience. Pension scheme. Send full details including age, experience, qualifications and present salary in confidence to: Box No. 1245, I.Prod.E., 10 Chesterfield Street, London, W.1.

Engineer. PERA requires an engineer with good command of English, to carry out surveys of production engineering literature, prepare articles, abstracts, etc. Good prospects and superannuation scheme. Applications to: Production Engineering Research Association, Melton Mowbray, Leics.

Production Engineers required during the next few weeks by a reputable and established light electrical engineering company engaged on the production of complex equipments. Vacancies exist in the following branches: (a) Estimation of tooling required prior to process planning for production; (b) process planning of machine operations for turning, milling and drilling; (c) process planning of press work operations from 6 tons to 100 tons. Applicants (who should be aged 25-35) must possess O.N.C. or equivalent, but preference will be given to those qualified to H.N.C. level. Toolroom experience on press tools, drill jigs, assembly fixtures and gauges is essential. A background on electrical, radio or television components is desirable. To successful applicants, good working conditions in a modern factory (on the south coast), superannuation scheme (housing) and a good salary are offered. Candidates should in the first instance submit full details of age, education, experience and salary expected in confidence to: Box No. 1246, I.Prod.E., 10 Chesterfield Street, London, W.1.

Planning Engineer required by electronic engineering company within 30 miles London. O.N.C. electrical or mechanical and previous experience of radio or telephone industry preferred. Salary up to £850 p.a. for right man. Permanent, pensionable position, offering excellent prospects. Apply: Box No. 1247, I.Prod.E., 10 Chesterfield Street, London, W.1.

Tool Draughtsman required with experience of tools, jigs and fixtures for batch production of electronic equipment. Commencing salary up to £750 p.a. 30 miles from London. Pension scheme in operation. Apply to: Box No. 1248, I.Prod.E., 10 Chesterfield Street, London, W.1.

Sub-Contract Engineer required to be responsible for placing and progressing of engineering contracts. Age 35-45 years. Expert knowledge of production and method planning, estimating and jig and tool design. Membership or Associate Membership of the Institution of Mechanical Engineers or Production Engineers desirable. Salary according to qualifications and experience. Write details to: Personnel Manager, Telcon Works, S.E.10.

Production Engineers wishing to strengthen their experience by taking a senior product design appointment at management level are invited to join a Midland firm of light engineering manufacturers. Good experience of mass production techniques covering sheet metal and casting is required, accompanied by a strong technical background, to enable the candidate to lead and plan the design and development activities of a factory of 1,000 employees. Commencing salary will be at least £1,500 p.a. Details of qualifications and experience should be sent to: Box I.J.290 c/o 191 Gresham House, E.C.2.

General Manager for small electrical manufacturers N.E. London, group subsidiary. Electrical sheet metal work, fabrications, assemblies, L.T. distribution, switchboards, switchgear, boxes, trunking, etc. Qualified electrical engineer with commercial and management experience, able to build present labour force of 80 in full employment area, and productive efficiency. £1,500 p.a. to commence. Fully detailed applications in confidence to: Director, Box No. 1249, I.Prod.E., 10 Chesterfield Street, London, W.1.

Works Manager of exceptional qualities is required by well-known company to take charge of all its production on the North East Coast including machining, light and heavy assembly and electrical work. Applicants must have a sound mechanical engineering training and experience in up-to-date methods of production and control. The position calls for a man of strong personality who is a firm but tactful disciplinarian. Prospects are excellent. Salary will be commensurate with ability and responsibilities and in any case will not be less than £1,500 p.a. The position is pensionable and assistance will be given with housing if required. Write giving details of age, previous experience and salaries earned to: Dept. B., Box No. 1250, I.Prod.E., 10 Chesterfield Street, London, W.1.

Chief Production Engineer. Applications are invited for appointment as Chief Production Engineer to a large engineering company in the London area. The Company is engaged on a wide range of light to medium/heavy production, covering small to large batch quantities. The appointment entails responsibility to the Production Manager for the planning and improvement of methods of production, the design and procurement of tools and equipment, the provision of special purpose machine tools and the acceptance of such equipment at manufacturers' works at home or abroad; together with control of the production engineering department of some 50 personnel. Applicants should have had experience enabling them to cover all the requirements in relation to machine shops (including single and multi-spindle bar autos and chucking autos, capstans and milling machines) and fitting and assembly shops embracing line assembly applications. Previous executive experience over a minimum period of 5 years is essential, and applicants should be in the age range 35-50. Membership of a recognised professional Institution will be an advantage. Applications giving full information regarding experience, qualifications and present salary, should be addressed to: Box No. 1251, I.Prod.E., 10 Chesterfield Street, London, W.1.

Advisory Service on Production Methods. PERA requires two engineers: (a) Mechanical or Production Engineer with good experience of production methods (specialised or general), age 25-35; (b) young engineer age up to 25, able to apply existing knowledge to production problems with imagination and initiative, and broaden his experience under supervision. In both cases duties may involve visits to engineering firms throughout the country. Good prospects and F.S.S.U. superannuation scheme. Applications to: Secretary, Production Engineering Research Association of Great Britain, Melton Mowbray, Leics.

Production Engineer for small highly organised clothing factory. Must have experience of flow production, single unit assembly, not necessarily clothing, and be conversant with Work Study techniques. Please apply with fullest details to: Managing Director. Box No. 1252, I.Prod.E., 10 Chesterfield Street, London. W.1.

Works Manager. Experienced in machine tool manufacture, capable of controlling labour and progressing sub-contract items. Wolverhampton area. Age 35-55. Permanency. Apply giving experience age and salary required to: Box No. 1253, I.Prod.E., 10 Chesterfield Street, London, W.1.

Works Superintendent. Capable of taking charge of small medium heavy engineering factory, machine tool manufacturers. Wolverhampton district; age 35-55. Apply stating age experience and salary required to: Box No. 1254, I. Prod.E., 10 Chesterfield Street, London, W.1.

Young Production Engineer. Progressive and old-established Midlands engineering company requires young production engineer (30-40) with exceptional drive and initiative, preferably with experience of controlling production operators in the motor industry. The post entails responsibility for achieving output for the increasing programme of work in the Company's automotive division. Great scope for advancement in a company geared to increasing its output con-

siderably in the next few years. All replies will be acknowledged and treated in the strictest confidence. Write giving full details of experience, technical qualifications, age and salary required to: Managing Director, Box No. 1255, I.Prod.E., 10 Chesterfield Street, London, W.1.

Tool Room Superintendent. East Midlands toolmaking firm employing 60 men specialising in production of high quality injection moulds and pressure casting dies requires Superintendent with intimate experience of diesinking including Keller, Gorton, Deckel, etc. Ability to collaborate with drawing office on mould design and tool planning essential. This is a permanent position with a well-established company, eligible for pension scheme. Please apply in own handwriting giving full details of previous experience, which will be treated in strictest confidence. Box No. 1256, I.Prod.E., 10 Chesterfield Street, London, W.1.

Works Productivity Engineer required by large specialised woollen manufacturing concern with factories in the North of England and Midlands. Applicants should have had practical experience of time and motion study and be capable of instituting and operating productivity bonus systems. Favourable pension scheme, give fullest particulars of past experience, age and approximate salary expected. Applications treated confidentially, to: Managing Director, Bury Felt Manufacturing Co. Ltd., Hudcar Mills, Bury, Lancashire.

Research & Development Work in Production Engineering. Work of a most interesting nature is being undertaken in the initiation and improvement of manufacturing methods and processes in the production of gas turbine engines. D. Napier & Son Limited, Acton, are carrying out investigation and development in the following fields of production engineering:- gas turbine blade manufacture, forging, stamping and extrusion methods and techniques, press methods of sheet metal forming, precision methods of sheet metal fabrication, metal machining methods and techniques, precision metal rolling, the metallic structure of welds, special purpose machine tools, quality control in the grinding, honing and lapping, of cutters, projection methods of inspection. We need capable men, prepared to give of their best as **Methods and Development Engineers** in exchange for good working conditions and salary. Applications are also invited for the vacancy of **Technical Reports Editor** to collect and present the findings of the Technicians in these fields. All applications, please, to: D. Napier & Son Ltd., Dept. C.P.S., Marconi House, Strand London, W.C.2, quoting Ref. S.A.30D.

Work Study Officer to join the staff of a growing industrial engineering department in a progressive company in the Manchester area manufacturing toilet soap, toothpaste and other toilet articles. A good practical experience and knowledge of method study, work measurement and ancillary subjects of greater importance than knowledge of the particular industry. Should be capable of working with the minimum of supervision and be at least O.N.C. level. Persons of the right mental approach, but without experience, will be considered as trainees. Apply stating salary, age and experience to: Personnel Manager, Box No. 1257, I.Prod.E., 10 Chesterfield Street, London, W.1.

Production Controller required for medium size light engineering works of very old established company in the West Midlands area engaged on batch production. The post will involve responsibility for co-ordinating all the production control functions within the works, and the person appointed would be responsible directly to the Works Manager. Knowledge of up-to-date production control methods essential, with practical experience in progress, stock control, material and works ordering procedures. Applicant must have good personality, drive and enthusiasm, with a strong sense of loyalty, and ability to lead the present production control team. Applicant should preferably not be over 40 years of age. Apply to: Box No. 1258, I.Prod.E., 10 Chesterfield Street, London, W.1.

A Chief Production Engineer is required by a light engineering Company in South London, employing approximately 2,000 persons. The successful applicant will first examine existing methods of manufacture and report his findings to the Board, after which he will be expected to install a modern production engineering service co-ordinating each of the Company's factories. Essential qualifications for this post must include previous experience in carrying out similar duties and a wide knowledge of manufacturing layouts on the mass production of mechanical and electrical components and instruments. Please write stating age, and full details of experience and qualifications. Box No. 1259, I.Prod.E., 10 Chesterfield Street, London, W.1.

Planning Engineer (Junior) required by reputable electrical engineering company with a modern factory in Essex. Applicants should have shop experience, a sound appreciation of manufacturing costs, knowledge of work simplification methods and ability to specify operations. A commencing salary of up to £850 per annum will be paid. Accommodation is available within 2/3 months and removal expenses will be paid. Interviews by appointment in Central London or at the factory. Please write stating age, qualifications and experience to: Box 4D, C4521, A.K. Advertising, 212a Shaftesbury Avenue, London, W.C.2.

Senior Production Engineer required by reputable electrical engineering company with a modern factory in Essex. Responsibility for basic development work on manufacturing methods mainly on light current electrical products in substantial quantities. Applicants must be highly qualified in the production field and capable of delegating and supervising detail work. A commencing salary of up to £1,200 per annum will be paid. Rented accommodation is available if required and removal expenses will be paid. Interviews by appointment in Central London or at the factory. Please write brief details of relevant particulars to: Box 4D, C524, A.K. Advertising, 212a Shaftesbury Avenue, London, W.C.2.

Production Engineer required for our Coseley (Staffordshire) Works, where we produce welded pressure pipework and tubular fabrications covering a wide range and involving most types of welding, pressing and machining. Applicants, age preferably 35-40 years, should possess first class qualifications and wide experience, should be well acquainted with modern production line lay-out and handling methods, and be capable of taking charge of design of all jigs and tools involved. Apply in writing to: The Secretary, Wellington Tube Works Limited, Great Bridge, Tipton, Staffordshire.

Planning Engineers. We have a number of vacancies for both Senior and Junior Engineers of proved ability who have specialised in Machine Shop Work. Applicants should have a sound practical knowledge based on extensive shop experience in the aircraft engine or similar industry. Please write, giving full details of experience and education to: The Personnel Officer, The De Havilland Engine Company Limited, Leavesden Aerodrome, Nr. Watford, Herts.

Planning Engineer required for layout and Materials Handling Department. Knowledge of this type of work and some draughting experience essential. Written applications only, to: The Personnel Officer, The De Havilland Engine Company Limited, Leavesden Aerodrome, Nr. Watford, Herts.

Technical Representative with production engineering knowledge is required by a large and progressive mechanical engineering company, to take charge of development of sales in connection with important new enterprises relating to automation in electronic trades. A knowledge of the electronic industry is required and some experience in introducing new processes into industry an advantage. Pension scheme. Housing problem recognised. Five-day week. Starting salary up to £1,500 according to age and experience. Write: Box No. 1260, I.Prod.E., 10 Chesterfield Street, London, W.1.

Jig and Tool Designer and Ratefixers. The British Tabulating Machine Company Limited, Letchworth, Herts, invites applications for the following positions: **Jig and Tool Designer.** Applicants must be conversant with modern tooling methods and practices and suitably qualified. **Ratefixers.** Previous experience is essential. Applicants should be able to calculate accurate operating times from drawings on machine and assembly operations. Commencing salaries will depend on experience and qualifications. Facilities include pension scheme and generous sick pay scales. Write giving personal history and present salary to: Personnel Officer.

Design and Development Engineers. The British Tabulating Machine Company Limited, Letchworth, Herts., have several vacancies in their Technical Division to offer to experienced engineers on work concerned with the development and design of high speed electro-mechanical accounting machinery. A four-figure salary is envisaged for men who are technically qualified and possess previous shop and design experience in the right field. Pension fund and sick pay facilities. Interview expenses paid. Applications should be addressed to: Personnel Superintendent, quoting reference: PE/628.

Estimator required. There is no age limit, but applicants should have practical experience to H.N.C. standard, and two years' experience of process planning and work study in light engineering. All the usual amenities, plus accessibility. Applications to: The Employment Officer, Smith's Motor Accessories, Limited, Cricklewood Works, N.W.2. Tel. No. Gladstone 3333.

Chief Process Engineer required to organise and supervise work of planning and processing department, large factory, in Glasgow. Applicant must be conversant with all types of modern machine tools, methods, and cutting theory, also, a thorough knowledge of sub-assembly, assembly and fitting operations. In addition, applicant should be familiar with modern welding, boilermaking and forging/blacksmith techniques. Technical qualifications — Higher National Certificate in Production or Mechanical Engineering or equivalent. Applications in writing, stating age, qualifications and experience in chronological order to: Box No. 1261, I.Prod.E., 10 Chesterfield Street, London, W.1.

Chief Ratefixer required for large engineering works in Glasgow. Applicant must be fully experienced man with a sound knowledge of all types of machining and fitting operations for medium/heavy work. Experience of welding, plating and boilermaking methods would be an advantage. The post is a monthly staff appointment and offers good promotion opportunities to a competent man who must have held a similar position, who has a sound knowledge of ratefixing and time study problems, and has the ability to handle men. Applicant will be responsible for organising and directing the work of approximately thirty-five ratefixers and time study engineers. Apply: Box No. 1262, I.Prod.E., 10 Chesterfield Street, London, W.1.

Works Manager to take full charge of manufacturing operations under Managing Director in well-known modern light-medium engineering works near London employing over 300. Must be experienced in modern management and production techniques for quantity production of quality work, including work study, planning modern production methods, jig and tool design, costing and recording of work, incentive schemes, and the general maintenance of discipline, enthusiasm and effort throughout the shops. Age 35-50, £2,000 upwards according to ability, experience and qualifications. Apply stating age, education, qualifications and positions held to: Box No. 1263, I.Prod.E., 10 Chesterfield Street, London, W.1.

Engineer required by PERA for duties which include visiting engineering firms throughout Great Britain, meeting executives and giving talks and demonstrations to production personnel. Applicants must have had considerable experience of production methods in the engineering industry. Good commencing salary for successful applicant with increments on merit. Car provided and travelling expenses paid. Superannuation scheme. Applications stating age, experience, qualifications, etc., to: Secretary, Production Engineering Research Association, Melton Mowbray, Leics.

Management Consultants and Industrial Engineers. A. G. Hayek and Partners Limited, Management Consultants and Industrial Engineers, are enlarging their team of Consultants and invite further applications from men with extensive practical experience in time and motion study in a senior capacity. Preference will be given to applicants with H.N.C. or equivalent, in age range 26 to 42. Participation in profit sharing scheme after completion of probationary period and prospects of advancement to senior status for men with initiative and the right personality. Apply with fullest details and salary requirements to the above at Federation House, Stoke-on-Trent.

Work Study Engineer required for a "Method Study" improvement programme involving works in many parts of the British Isles. Applicant should have had experience in the application of method study techniques and be capable of working on his own initiative. Excellent salary and conditions. Apply to: Box No. 1264, I.Prod.E., 10 Chesterfield Street, London, W.1.

Senior Work Study Engineer required by a progressive company of transformer manufacturers in the West London area. Mechanical engineering experience is more important than electrical engineering experience. This is an excellent opportunity for a man with drive and initiative. Pension scheme, etc. Write to: The Technical Director, Box No. 1265, I.Prod.E., 10 Chesterfield Street, London, W.1.

Senior Design and Detail Draughtsmen urgently required. Permanent pensionable posts at good starting salaries are offered to really good men experienced in mechanical handling. Adaptable men experienced in light structural or mechanical work will be considered. Good modern offices and staff canteen. Apply giving full details of qualifications and previous experience to: Contracts Engineer, J. Collis & Sons Limited, Regent Square, Gray's Inn Road, London, W.C.1.

Works Manager required to take charge of Technical Development, Work Study, Production and Maintenance of Equipment, Plant and Services in modern factory of 100,000 square feet situated in pleasant surroundings approximately ten miles south of London. The Company's industry falls into three broad groups as follows: (1) ferrous and non-ferrous light engineering of small to medium metal cabinets and mechanisms, demanding knowledge of modern press tool practice, special purpose machinery and metal finishing processes; (2) printing and conversion of paper and plastics into office stationery and equipment; (3) machining, cabinet-making and polishing of high class office furniture. Qualified production engineers possessing suitable experience of the majority of these requirements, coupled with up-to-date detailed knowledge of Work Study and labour cost control procedures, are invited to apply for this post, which commands an attractive salary with excellent prospects. Please submit comprehensive details of industrial experience and academic attainments in confidence with first application to: E. F. Shannon, Chairman, The Shannon Limited, Shannon Corner, New Malden, Surrey.

Draughtsmen, Estimators, Contract Engineers. Production development engineering department of a rapidly expanding conveyor company requires the following grades of staff to meet its expansion programme: **Draughtsmen** with a mechanical engineering apprenticeship and technical qualifications equivalent to Higher National standard; **Estimators** with some years estimating experience in a mechanical engineering business; **Contract Engineers** with a mechanical engineering apprenticeship, technical experience, preferably equivalent to A.M.I.Mech.E., and a production engineering background to support development and control of conveyor projects to customers' special purposes. Salary and promotion prospects will be excellent for men with proved ability. Applications are invited only from men who can

justify themselves and grow in this rapidly developing conveyor division. Applications should be addressed to: The Managing Director, Material Handling Division, Fisher & Ludlow Ltd., Bordesley Works, Birmingham, 12.

Superintendent. C.I.C. Engineering Limited, Castle Cary, Somerset, requires a Superintendent for a small production unit, making components for the shoe trade. He will be responsible to the Managing Director. Knowledge of press work and heat treatment an advantage. Age limit 28-35 years. Salary range £800-£1,200 per annum, depending upon qualifications and experience. Please apply in writing to: The Personnel Department, C.I.C. Engineering Limited, Street, Somerset, marking your envelope "Private".

Experienced Design Engineer, aged 28-40 required by expanding Company manufacturing special purpose machinery. Qualifications at least H.N.C. Experience in maintenance and operation of machinery an advantage. Applications stating age, experience, qualifications and salary required will be treated in confidence, and should be addressed to: The Personnel Officer, C.I.C. Engineering Limited, Street, Somerset, marked "Private".

Ratefixer for general engineers, not mass production; used to all machining operations; experience of plate work an advantage. Good salary and pension scheme, with scope for advancement for right man. Box No. 1266, I.Prod.E., 10 Chesterfield Street, London, W.1.

Time Study Engineer required by Felt & Tarrant Limited, manufacturers of the Comptometer. Applications are invited from men with practical experience on Time Study work on light engineering. This position occurs in the expanding N.W. London factory, still in the course of being staffed. Salary according to qualifications. Pension scheme. Write stating age and full details in confidence to: Box No. 1267, I.Prod.E., 10 Chesterfield Street, London, W.1.

Production Study. Batchelors Peas Limited, Sheffield, require a qualified man to fill a senior vacancy in the production study department. Applicants should have had industrial and administrative experience. Preference will be given to those with experience in the following fields:- Production, maintenance (repairs, construction and installation), labour and materials controls. Application in costs, accounts and office work, and if possible, in industrial statistics. They should have appropriate technical qualifications of degree or equivalent standard. The duties consist of developing the existing production study work and the extension of this work to other sections, not necessarily on the production side. The starting salary offered will be commensurate with the qualification and experience of the person appointed, but should be in the range between £900/1,200. Apply: Personnel Officer, Batchelors Peas Limited, Wadsley Bridge, Sheffield.

Trained Engineer. Engineering company of world wide reputation in the Manchester area has a vacancy with exceptional opportunities for a trained engineer of about 35 years of age with wide knowledge of works production of non-repetition general engineering, to control the flow and distribution of work through the foundry, machine and erection shops in order to maintain the delivery of finished machines as laid down by the directors. Commencing salary between £1,250 and £1,750 depending on experience and ability. Permanent pensionable appointment. Apply: Box No. 1268, I.Prod.E., 10 Chesterfield Street, London, W.1.

Draughtsman (Junior) required for materials handling equipment design section. Ordinary National Certificate standard essential. Written applications only, to: The Personnel Officer, The De Havilland Engine Company Limited, Leavesden Aerodrome, Nr. Watford.

EDUCATIONAL APPOINTMENTS

Northampton Polytechnic, St. John Street, London, E.C.1.
Lecturer required for full-time permanent pensionable staff to instruct students in instrument engineering. Candidates should possess B.Sc., H.N.C. or equivalent, and have wide industrial experience in instrument making, instrumentation and/or automatic control. Salary on Burnham scale, commencing at £1,000, rising to £1,113. Excellent opportunity in expanding department for entering the technical teaching profession. Apply for form to Secretary.

Wolverhampton and Staffordshire Technical College.
Lecturer in Department of Production Engineering and Management.
Applications invited for Lecturer in Department of Production Engineering and Management, mainly for technical management subjects in B.I.M. courses. Ability to assist with H.N.C. and sandwich courses an advantage. Candidates must hold a degree and/or equivalent professional qualification with appropriate industrial experience. Grade B Assistant to teach metal working processes and practice in City and Guilds and National Certificate courses. Aptitude for machine tool demonstration. Industrial experience with possession of full technological certificate in machine shop engineering and/or H.N.C. required. Salaries in accordance with Burnham Technical Scales: Lecturer £965-£1,065, Grade B £525-£820 with additions for training, experience, etc. Further particulars and forms of application from G. W. R. Lines, Clerk to the Joint Education Committee, Education Offices, North Street, Wolverhampton, (stamped addressed envelope).

Loughborough College of Technology.
Machine Shop Superintendent. Applications are invited for the position of Machine Shop Superintendent. The person appointed will be responsible for the practical instruction of full-time engineering students in engineering workshop production processes and in production in a machine shop which contains milling, slotting, planing, shaping, and gear cutting machines. Applicants should hold good qualifications in machine shop engineering or production engineering and have had good industrial experience. Salary will be paid according to the scale for Assistant Lecturers, Grade B, of the Burnham Report 1954, namely, £525-£25-£820. Application forms and further particulars may be obtained from The Registrar, to whom completed applications should be returned as soon as possible.

Coventry Technical College.
Full-time Assistant Grade B in Mechanical Engineering Department.
Required for January 1956 or sooner if possible, full-time Assistant Grade B in Mechanical Engineering Department. Candidates should have good technical qualifications and industrial experience in engineering. Previous teaching experience advantageous. Burnham Technical Scale salary £525 x 25—£820 (plus additions for qualifications and training). Application forms and further particulars from Director of Education, New Council Offices, Coventry.

North Staffordshire Technical College, Stoke-on-Trent.
Applications are invited for the post of Grade "B" Assistant Lecturer required mainly for lecturing in management subjects from the industrial aspect, duties to commence as soon as possible. The appointment would provide an excellent opportunity for a production or industrial engineer interested in lecturing on managerial subjects to advanced, "sandwich" and part-time students, supervisors and foremen from the local industries, including subjects for the Intermediate Certificate in Management. Applicants should hold a Higher National Certificate or equivalent qualification and should have had adequate industrial experience, preferably including experience in production planning or work study or other aspects of industrial management. Salary on the Burnham scale (£525 x £25—£820 per annum) with full additions for training, graduate qualification and experience. Applications giving details of qualifications, training and experience, together with the names of two referees, should be sent to the Principal immediately.

Manchester College of Technology, Manchester, 1.
Development Engineer.
The College is about to undertake a study of the design of machine tools which are to be specially suitable for automatic electronic control. The project is to be sponsored by the National Research Development Corporation. Applications are invited for:- **Development Engineer.** Candidates should be University Graduates in mechanical engineering; experience in the design of machine tools, though not essential, would be an advantage. The salary for this post will be within the range of £900—£1,200, dependent upon qualifications and experience. Further particulars of appointment may be obtained from the Registrar. Application should be made in writing to the Registrar, College of Technology, Manchester, 1, and should include full particulars of the candidate's qualifications and experience and the names of two persons of whom enquiries may be made. The last date for the receipt of the applications is *Saturday, 17th December, 1955.*

Twickenham Technical College, Egerton Road, Twickenham, Middlesex.
Assistants (Grade B) to teach Production engineering subjects. Required as soon as possible, Assistant (Grade B) to teach production engineering subjects up to Higher National Certificate level and Final Year City and Guilds standard in Machine Shop Engineering. Candidates should hold a Degree or equivalent and have had good industrial and preferably some teaching experience. Salary in accordance with the Burnham (Technical) Report, 1954. Application forms and further particulars (stamped addressed foolscap envelope) from the Principal, to whom completed forms should be returned within fourteen days of the appearance of this advertisement.

Municipal Technical College, Halifax.
Workshop Instructor in the Department of Engineering.
Applications are invited for the post of Workshop Instructor in the Department of Engineering. Candidates should hold a Final City and Guilds Certificate in Machine Shop Engineering or similar qualifications. Salary in accordance with Burnham scale for Grade A Assistants, £450 x £18—£725, point of entry to scale depending upon previous experience. Further particulars from the Principal, Municipal Technical College, Halifax.